5. CHEMICAL OXIDATION/STABILIZATION

Chemical oxidation is an ambient pressure, low temperature (<90°C) treatment process that employs aqueous solutions of strong oxidants to convert halogenated organic contaminants in solids and liquids to carbon dioxide, water, and halide salts. Following chemical oxidation, a stabilization step can be employed for treatment of residual metals to comply with RCRA LDRs. Stabilization produces a solid waste form (no free liquids) that can be disposed into appropriate disposal facilities. These two steps form a treatment train referred to in this evaluation as Chemical Oxidation/Stabilization (CO/S).

Removing organic contamination nonthermally typically requires a chemical reaction to mineralize the contamination to carbon dioxide and water. Such reactions may be either reductive or oxidative. Recently, numerous groups in both the United States and Europe have applied oxidative principles to waste treatment, and they have made substantial progress in the last decade toward understanding the mechanistic pathways, kinetics, and engineering aspects of the process (CRC, 2001). As the CO/S process has matured, engineering and regulatory agencies have embraced the new technology. Specific examples of the CO/S process in the United States, having been selected and considered, include but are not limited to:

- Hanford's K Basin—Direct Chemical Oxidation was chosen as the preferred technology in 1998 to treat PCB-contaminated sludge (Ashworth & Flament, 1998).
- Melton Valley Watershed at the Oak Ridge National Laboratory—an Interim Action Record of Decision was signed in September of 2000, which included chemical oxidation for the remediation of the T-1, T-2, and HFIR Tank Cleanup (DOE/OR/01-1826&D3, 2000).
- Savannah River Site—Evaluation of chemical oxidation is under way for the 1.25M gallon Tank 48 remediation. A decision to adopt this technology is expected in March of 2003.

For the purposes of the evaluation in this report, it is assumed that the organic destruction will be via the oxidation mechanism. There are various candidate oxidants for the destruction of organics. Among these are:

- Fentons Reagent (Fe^{+3}, H_2O_2)
- Peroxydisulfate solutions
- Permanganate solutions.

Previous studies using sodium peroxydisulfate showed this to be an acceptable candidate oxidant for the V-tank wastes (PTP, 2002) (DOE, 1998). Detailed information concerning the oxidation chemistry of sodium persulfate is presented in Appendix H. Previous studies using sodium peroxydisulfate indicate that temperatures up to 80°C are optimal to thoroughly oxidize the target organics. At this temperature, volatile organics (TCE, PCE, TCA, etc.) and saturated water vapor (vapor pressure = 6.87 psi) will occupy the headspace. A blower at the backend of the off-gas system, ensuring slight negative pressures, will be used to allow these volatiles to exit the reaction vessel and be processed through an off-gas system that will condense the volatiles and return them to the reaction vessel. VOCs that are not condensed will be swept through carbon beds and collected. Unlike vitrification and thermal desorption, the liquid phase will remain with the primary waste form.

Two alternatives have been identified for CO/S of the V-tank liquid and sludge. The alternatives are:

- In situ chemical oxidation followed by stabilization (IS-CO/S)
- Ex situ chemical oxidation followed by stabilization (ES-CO/S).

The first alternative will use the existing V-tanks as the reaction vessels to significantly reduce the radiation exposure and shielding requirements relative to an above ground process. The second alternative will use an above ground tank for the reaction vessel and has the flexibility to design this vessel without the constraints of existing structures (e.g., tank manhole dimensions). However, this advantage is somewhat offset, because ES-CO/S will require significant radiation shielding and remote or semi-remote operating methods for the reaction vessel and interfacing equipment, transfer of oxidized waste to the grouting and containerization subsystem, and the storage, handling, and transportation of the filled waste containers.

5.1 Key Assumptions

5.1.1 In Situ CO/S Assumptions

- Available lifting capacity will be adequate for grouted tank removal
- Existing V-tank vessel material and condition are adequate for process chemistry, i.e. destruction of chlorinated organics (TCE, PCE, PCB, etc.) leading to significant concentrations of free chloride
- Waste and grouting agents can be adequately mixed in place
- The contents of Tank V-9 shall be removed and transferred to another V-tank, preferably Tank V-2
- The oxidized and pH adjusted waste can be successfully grouted to obtain a compressive strength meeting ICDF WAC requirements
- A Determination of Equivalent Treatment for both PCB and mercury will be granted for the CO/S process[c,d] [Note: The Determination of Equivalent Treatment for high subcategory mercury (40 CFR 268.44 (b) – petition for a variance from the treatment standard) is conservatively based on separate treatment of Tank V-9.]
- Required destruction efficiency for target organics that are strongly partitioned to the solid and oil phase can be achieved through wet chemistry oxidation. This assumption covers PCB, BEHP, TCE, PCE, etc.

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c. Treatment and disposal of the PCBs shall be managed under a risk based petition for PCB Remediation Waste under 40 CFR 761.61(c).

d. The contents of Tank V-9 are hazardous for mercury (0.256 mg/L in Tank V-9 versus a characteristic limit of 0.2 mg/L). In addition, the total concentration of mercury is 1648 mg/kg. The sum effect of these two concentrations places the contents of Tank V-9 into the treatment standard of RMERC (retort of nonwastewaters that exhibit the characteristic of toxicity for mercury and contain greater than or equal to 260 mg/kg of total mercury).

- A MACT compliant system is not considered necessary for this low temperature, aqueous-phase treatment method
- GAC debris will contain a total organic concentration of less than 500 ppm following macroencapsulation as required by the ICDF WAC (See last bullet of Section 2.1.)
- Mercury is assumed to be in an oxidized state following chemical oxidation and the grout formulation is assumed to provide significant fixation of available mercury
- The remaining empty space in the grouted V-tanks can be filled with contaminated soil from around the tanks or with additional grout at the ICDF. The contaminated soil or grout will not be put into the tanks until after they are at ICDF, due to crane and transportation weight limitations.

5.1.2 Ex Situ CO/S Assumptions

- The oxidized and pH adjusted liquid waste can be successfully grouted to obtain a compressive strength meeting the ICDF WAC requirements.
- A Determination of Equivalent Treatment for both PCB and mercury will be granted for the CO/S process[e,f]. [Note: The Determination of Equivalent Treatment for high subcategory mercury (40 CFR 268.44 petition for a variance from the treatment standard) is conservatively based on separate treatment of Tank V-9.].
- Required destruction efficiency for target organics that are strongly partitioned to the solid and oil phase can be achieved through wet chemistry oxidation. This assumption covers PCB, BEHP, TCE, PCE, etc.
- A MACT compliant system is not considered necessary for this low temperature, aqueous-phase treatment method.
- GAC debris will contain a total organic concentration of less than 500 ppm following macroencapsulation as required by the ICDF WAC. (See last bullet of Section 2.1.)
- Mercury is assumed to be in an oxidized state following chemical oxidation and the grout formulation is assumed to provide significant fixation of available mercury.
- The remaining empty space in the grouted V-tanks can be filled with contaminated soil from around the tanks or with additional grout at the ICDF.

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e. Treatment and disposal of the PCBs shall be managed under a risk based petition for PCB Remediation Waste under 40 CFR 761.61(c).

f. The contents of Tank V-9 are hazardous for mercury (0.256 mg/L in Tank V-9 versus a characteristic limit of 0.2 mg/L). In addition, the total concentration of mercury is 1648 mg/kg. The sum effect of these two concentrations places the contents of Tank V-9 into the treatment standard of RMERC (retort of nonwastewaters that exhibit the characteristic of toxicity for mercury and contain greater than or equal to 260 mg/kg of total mercury).

5.2 Technical and Functional Requirements

5.2.1 In Situ CO/S

- Process temperatures shall be achieved and maintained by inserting a heating unit through the V-tank manhole as well as by natural heat transfer through tank walls
- The AEA system, or equivalent, shall be able to transfer the entire contents of Tank V-9 without leaving significant residual heel solids
- The AEA system, or equivalent, shall allow the reaction to proceed to the desired endpoint through adequate in-tank mixing
- The monitoring system shall be able to measure pH, temperature, chloride concentration, etc., within the tanks
- Sodium hydroxide solution shall be added to the tank periodically in accordance with the pH oxidation requirements
- The AEA system, or equivalent, shall provide the capability for periodic sampling for: (1) Organic analysis (VOC/SVOC) to indicate the end of the oxidation step, and (2) Analyses for constituents and properties important to the stabilization step.

5.2.2 Ex Situ CO/S

- The reaction vessel shall have a corrosion resistant (e.g. glass-lined) interior to adequately withstand chloride attack
- Process temperatures shall be achieved and maintained by inserting a heating unit in the reaction vessel as well as by natural heat transfer through the vessel walls
- The AEA system, or equivalent, shall be able to transfer the entire contents of Tanks V-1, V-2, V-3, and V-9 to the reaction vessel without leaving significant residual heel solids
- The reactor mixer set-up shall have adequate mixing within the reaction vessel to allow the reaction to proceed to the desired endpoint
- The monitoring system shall be able to measure pH, temperature, chloride concentration, etc., within the reaction vessel
- Sodium hydroxide solution shall be added to the tank periodically in accordance with the pH oxidation requirements
- The capability for periodic sampling of the oxidation vessel shall be provided for: (1) organic analysis (VOC/SVOC) to indicate the end of the oxidation step, and (2) analyses for constituents and properties important to the stabilization step.

5.3 Major Process Steps

5.3.1 Chemical Oxidation Components

The chemical oxidation phase of the process will take place in Tanks V-1, V-2, and V-3 for the in situ case. For the ex situ case, the contents of each V-tank will be transferred to a 3,500-gallon glass-lined reaction vessel (GLRV) for oxidation. This vessel will be used with the following components:

Electrical Heater Element

Electrical resistance heating elements will be inserted into the existing manhole to facilitate heating V-tank contents. It is assumed that oxidation with peroxydisulfate is an exothermic reaction which will promote additional tank-heating.

Instrument Probe Bundle

In order to accurately monitor and control chemical oxidation processes, various instruments will be required. These will include a pH monitor, pressure monitor, CO_2 off-gas monitor, and temperature monitor.

AEA System

In addition to the surface skid-mounted components of the AEA system (or equivalent), an in-tank extraction pipe with a custom nozzle will be required to facilitate mixing and extraction of the V-tank waste.

5.3.2 Off-Gas Components

Although the off-gas volume is expected to be minimal due to the relative low temperatures anticipated during oxidation, an off-gas system is proposed for processing and treating the potential constituents to preclude any undesirable emissions. The projected off-gas flow rate is 100 cfm. This is based on a peak dry CO_2 generation rate of 42 cfm and assuming this CO_2 stream is saturated with water vapor at 80°C.

Condenser

A condenser will cool the saturated off-gas stream and remove most of the moisture. This will reduce both the mass and volumetric flow in the off-gas stream. The condenser will be supplied with locally available cooling water at about 10 gpm and, allowing for an upper approach temperature of 20°C, will discharge a gas stream saturated at 21°C. The condensate will be directed back into the reaction vessel for further organic destruction.

Demister

The nature of the process is such that fine particulates are not expected, so a conventional mesh demister is considered adequate for dealing with liquid droplets. This unit will drain back to the reaction vessel with the off-gas condensate.

Reheater

It will be necessary to heat the off-gas stream above the dew point to protect downstream components from condensation.

SGAC Filters

This SGAC bed will trap both mercury vapors and VOCs. Separate beds for GAC and SGAC may be used if modeling and design calculations indicate that separate beds will be necessary.

HEPA Filter

A conventional HEPA filter will trap particulates that may be present in the off-gas stream, though none are expected.

Blower

A blower with enough flow and head capacity will be required to maintain a negative pressure throughout the system.

Caustic Scrub (Optional)

The destruction of organic chlorides by the persulfate reaction will liberate HCl and/or Cl_2 into the off-gas stream. Depending on the concentration and the release limits, it may be necessary to include a caustic scrub column in the off-gas train. Spent scrub solution will be returned to the process vessel. For the process flow diagrams, the caustic scrub was not included.

5.3.3 Grouting of Oxidized Residuals

Once the slurried V-tank wastes achieve regulatory compliance through oxidation, the resulting slurry will be solidified using grout.

Grouting In Situ

For the in situ case, all chemical oxidation and grouting of the oxidized wastes will take place within the buried V-tanks. Grouting will take place using the multi-point grout injection (MPI) process or equivalent. The MPI process consists of a delivery process that injects grout and mixes it with residual waste.

Tank Excavation

Following grouting, each tank will be excavated and transported to the ICDF. Sufficient grout will have been added to the in situ tanks only to solidify and stabilize the wastes, thus, minimizing the resulting tank weight and facilitating tank removal and transportation. Ultimately, to meet the ICDF WAC, the remaining empty volume in the tanks must be filled. This volume can be filled with contaminated soil from around the V-tanks or with additional grout once at the ICDF. The weight of the partially grouted Tanks V-1, V-2, and V-3 is estimated to be approximately 60 tons each. The excavation, removal, and transport of the V-tanks is assumed to be achievable with existing INEEL cranes so long as there is no more than a 20-ft radius from the center of mass of each tank to the fulcrum of the crane. Transportation of each tank can similarly be achieved through the use of existing INEEL equipment. If it is determined that existing INEEL equipment could not be utilized, larger equipment would need to be procured. For the basis of this analysis, transportation equipment procurement has not been baselined into the cost analysis for this treatment alternative.

Grouting Ex Situ

Following oxidation, the slurried waste will be transferred from the above ground reaction vessel with a separate pump. This pump will provide feed to a mixer/extruder, where the slurry is grouted, containerized in 55-gal. drums, and transported to the ICDF for disposal.

5.4 Mass Balance Summary

Mass balance calculations were completed for this technology to determine the concentrations of the CFTs and other constituents. Table 14 presents summaries of the CFT calculations from key steps of the process. The numbered waste streams correspond with the process flow diagrams in Figures 19 and 21. Further information on these and other constituents can be found in the detailed mass balance calculations included in Appendix C.

Table 14. Summary mass balance table of IS-CO/S and ES-CO/S.

Stream Name	V-tanks Contents	End of Oxidation	Grouted Waste	GAC Filter	SGAC Filter	HEPA Filter
Stream Number	**1**	**2**	**3**	**4**	**5**	**6**
Volume (L)	2.24E+04	3.15E+04	6.70E+04	4.16E+02	4.16E+02	3.00E+02
Mass (kg)	2.26E+04	3.29E+04	1.15E+05	1.67E+02	1.67E+02	1.0E+01
Component						
Inorganics						
Cd (mg/kg)	2.02E+01	1.39E+01	3.96E+00	0.00E+00	0.00E+00	0.00E+00
Chlorides (mg/kg)	1.36E+02	7.99E+02	2.28E+02	0.00E+00	0.00E+00	0.00E+00
Cr (mg/kg)	5.96E+02	4.09E+02	1.17E+02	0.00E+00	0.00E+00	0.00E+00
Pb (mg/kg)	2.82E+02	1.93E+02	5.53E+01	0.00E+00	0.00E+00	0.00E+00
Hg (mg/kg)	2.59E+02	1.78E+02	5.08E+01	0.00E+00	3.50E+01	0.00E+00
VOCs						
PCE (mg/kg)	2.37E+02	1.46E+00	4.18E-01	6.41E+01	0.00E+00	0.00E+00
TCA (mg/kg)	1.05E+02	7.20E-01	2.06E-01	2.84E+01	0.00E+00	0.00E+00
TCE (mg/kg)	8.54E+02	2.93E+00	8.37E-01	2.31E+02	0.00E+00	0.00E+00
SVOC						
BEHP (mg/kg)	9.10E+02	6.24E+01	1.78E+01	6.16E+01	0.00E+00	0.00E+00
PCBs (mg/kg)	3.59E+01	3.69E+00	1.06E+00	2.43E+00	0.00E+00	0.00E+00
Radionuclide						
Cs-137 (nCi/g)	1.98E+03	1.36E+03	3.88E+02	0.00E+00	0.00E+00	0.00E+00
Sr-90 (nCi/g)	3.68E+03	2.52E+03	7.21E+02	0.00E+00	0.00E+00	0.00E+00
TRU (nCi/g)	8.57E+00	5.88E+00	1.68E+00	0.00E+00	0.00E+00	0.00E+00
Other						
Total Organic Carbon (ppm)	2.53E+04	1.74E+02	4.96E+01	0.00E+00	0.00E+00	0.00E+00

* Chlorides are reflective of dissolved free chloride ion in solution

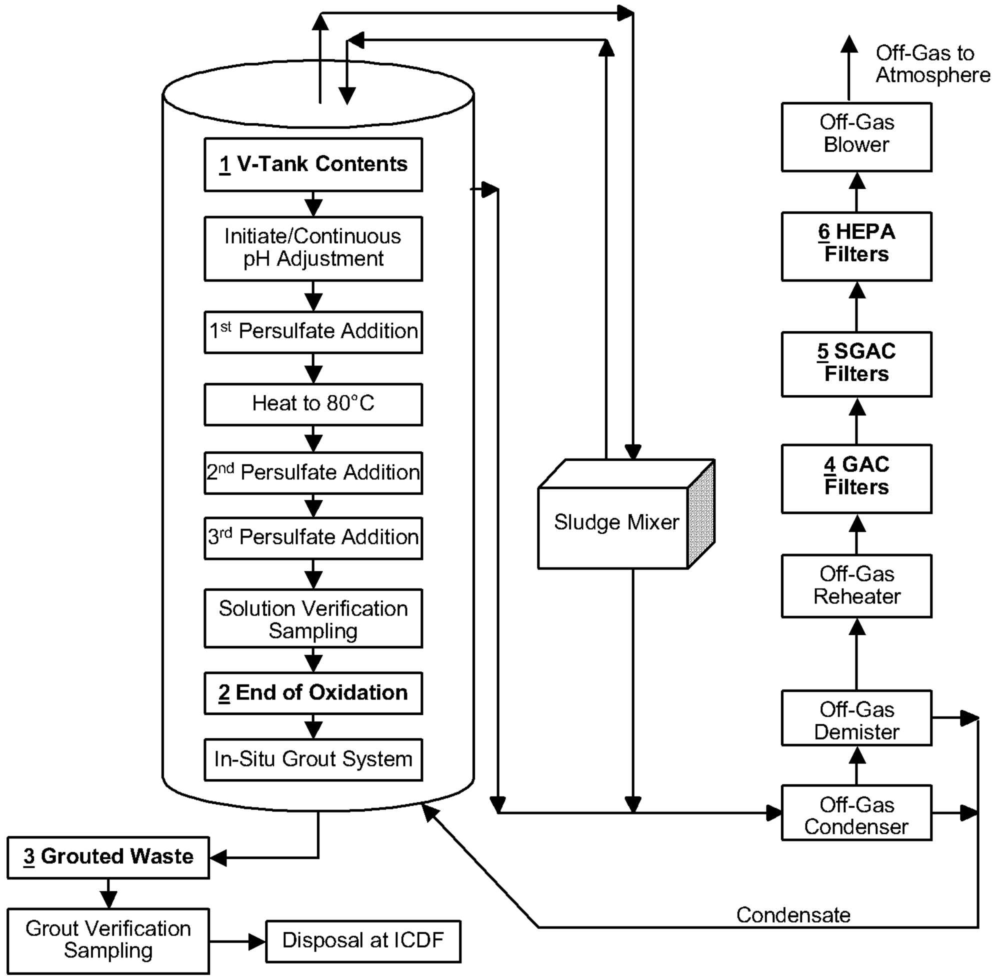

Figure 19. In situ chemical oxidation/stabilization overall process flow diagram.

5.5 In Situ Chemical Oxidation/Stabilization

In situ CO/S is proposed as a batch process occurring in Tanks V-1, V-2, and V-3 in sequence. The contents of V-9 will be transferred to V-2 prior to processing through the use of the AEA system, or equivalent. This system will transfer liquid from Tank V-9 into Tank V-2, and could possibly be used to facilitate the addition and mixing of the chemical oxidant with the waste throughout the chemical processes. Following the transfer of Tank V-9 contents into V-2, various in-tank components will be placed into Tanks V-1, V-2, and V-3. These components consist of an electrical heater element, an instrument probe bundle, and the fluidic jet system nozzle. See Figure 19 for a process flow diagram of this technology.[g]

g. Following chemical oxidation, these components will be sacrificed in place in order to reduce potential radiation exposure resulting from the decontamination.

Once the components are in place, the tank contents will be pH adjusted to 12 with a 50 wt% solution of NaOH. The solution will be maintained at an alkaline pH throughout the process with NaOH, as basic solutions are favored in treating halide-rich compounds such as chlorinated solvents and PCBs. The persulfate oxidant (29 w% solution, based on persulfate solubility at room temperature) will be added in three successive aliquots.

The first aliquot will be added while the solution is at ambient temperature (approximately 20°C) and will consist of a volume of persulfate solution equal to 20% of the initial volume of waste in each tank.[h] Adding the first aliquot of persulfate before heating to 80°C will allow the initiation of chemical oxidation prior to the increase of volatility corresponding to higher process temperatures. This will minimize the mass of volatile organic that must be captured in the GAC bed.

During this first stage of low temperature operations, the solution will be sampled and analyzed for VOCs. Once it is determined that compliance will be achieved for VOCs through further processing and stabilization, the solution will be heated to 80°C to increase the efficiency of oxidation. The solution will be held at 80°C for the remainder of the chemical processing. It is estimated that this first stage of chemical oxidation will take approximately 120 hours to complete.

The second aliquot will consist of a volume of persulfate solution equal to 10% of the original waste volume. Upon addition of the second aliquot the mixture will be allowed to further react for approximately 72 hours. The third and final aliquot, consisting of a volume equal to 10% of the original waste volume, will then be added, and the resulting mixture will react for approximately 48 hours. Upon completion of the final reaction step, the oxidized liquid waste will be sampled and analyzed for the selected contaminants listed in Section 1. A discussion of the process DREs for some of the key selected contaminants is given in Appendix H. If satisfactory DREs are achieved (limiting DRE s are ~99.5% for TCE in batch of V2/V9 combined and ~90% for BEHP in all batches), the resulting liquid waste will proceed to the next phase of processing. If sufficient DREs have not been achieved, then the mixture will be further reacted until compliance is achieved. If sufficient DREs still have not been achieved, the following would be performed, in order of preferred action:

1. Add a catalyst and increase the temperature (stay below the temperature where the water would be noticeably boiling)
2. Add more oxidant and wait for a specified period
3. Raise the temperature and begin to desorb some of the organic contamination and bypass the condenser for adsorption onto GAC beds.

Once satisfactory DREs have been achieved, the resulting liquid waste will be cooled for approximately 24 hours until it reaches an optimal grouting temperature range between 15 and 25°C (Fonseca, 2002). In-tank grouting will be facilitated through the use of an MPI system that will pump a concentrated wet grout mixture into the tank through a nozzle array to provide vigorous mixing and grouting of the V-tank waste (DOE, 2001).

h. The amount of aliquot addition is based on recommendations from work at MSE. Future treatability studies may determine that different aliquot volumes are necessary.

5.5.1 Disposition Pathways

Following grouting, each tank will be excavated and transported to the ICDF. Sufficient grout will have been added to the in situ tanks only to solidify and stabilize the wastes, thus, minimizing the resulting tank weight and facilitating tank removal and transportation. Ultimately, to meet the ICDF WAC, the remaining empty volume in the tanks must be filled. This volume can be filled with contaminated soil from around the V-tanks or with additional grout once at the ICDF.

The weight of the partially grouted Tanks V-1, V-2, and V-3 is estimated to be approximately 60 tons each. The preliminary opinion of INEEL hoisting and rigging subject matter experts is that the excavation, removal, and transport of the V-tanks can be achieved with existing INEEL cranes. That is assuming that there is no more than a 20-ft radius from the center of mass of each tank to the fulcrum of the crane. Transportation of each tank can similarly be achieved through the use of existing INEEL equipment (Torres, 2002).

All of the products and by-products of this process will be targeted for disposal in the ICDF (see Figure 20). Table 15 lists the wastes and their disposition. If the GAC filters are allowed to be classified as debris and if the total organic content is less than 500 ppm, the assumption is that disposal in the ICDF landfill is a possibility. (See last bullet of Section 2.1.) If the total organic content is greater than 500 ppm, due to lower than expected DREs (or VOC condensate return efficiency) or if the GAC filters are not allowed classification as debris, the waste will be shipped off-Site for disposal.

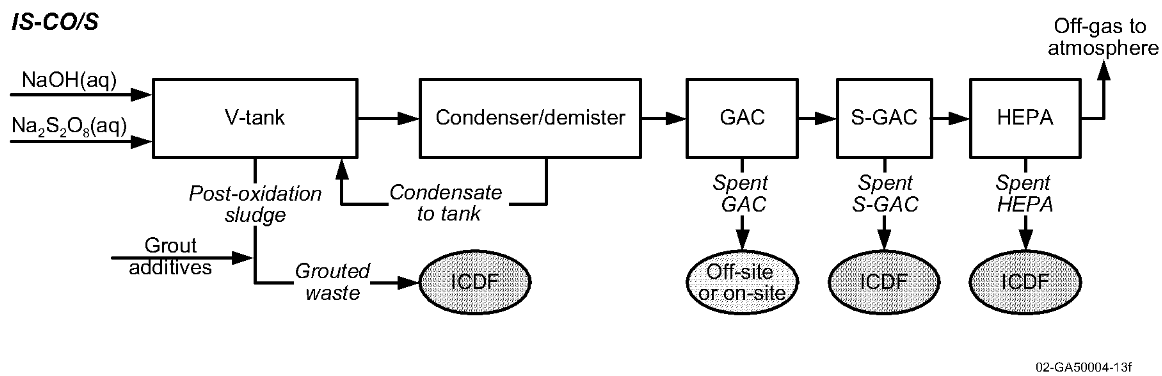

Figure 20. Summary of IS-CO/S waste distribution.

5.6 Ex Situ Chemical Oxidation/Stabilization

Ex situ CO/S (ES-CO/S) is proposed as a batch process occurring in a GLRV. Although it is possible to chemically oxidize volumes of waste smaller than entire tank volumes, it is assumed that three batches would be processed consisting of the contents of the individual Tanks V-1 and V-3, and the combined contents of Tanks V-2 and V-9.

The high concentration of TCE in Tank V-9 will require a DRE of 99.5% for TCE in the combined Tanks V-2/V-9 batch to achieve regulatory compliance. An alternative approach, if required, calls for the transfer of V-9 contents to the reactor vessel followed by the addition of excess persulfate for the

Table 15. Summary of waste types, volumes, expected treatments, and expected disposition for IS-CO/S.

Generated Waste Type	Volume	Expected Treatment	Expected Disposition
PRIMARY WASTE	**2462 m^3**		
Grouted waste (in tank) (Item 3 in PFD)	75 m^3	Complete	ICDF
Contaminated Soil/tanks (from V-tank AOC)	2387 m^3	Excavate	ICDF
SECONDARY WASTE	**10 m^3**		
GAC Filters (Item 4 in PFD)	1 m^3	Macroencapsulation for disposal	ICDF
SGAC Filters (Item 5 in PFD)	1 m^3	Macroencapsulation for disposal	ICDF
HEPA Filters (Item 6 in PFD)	0.3 m^3	Macroencapsulation for disposal	ICDF
Used PPE, consumable materials, non-recoverable equipment	8 m3	Macroencapsulation for disposal (as needed)	ICDF

treatment of V-9 contents prior to the addition of Tank V-2 contents.[i] This will allow the focused application of the chemical oxidant to TCE in order to maximize destruction efficiency and kinetics. As a further contingency, if focused chemical oxidation of TCE cannot achieve the required DRE of 99.5% or greater, the TCE could be desorbed and bypass the condenser for capture on the GAC filter. In this scenario the GAC filter will likely exceed 500 ppm organic content, and the resulting waste will require off-Site disposal. Prior to processing the contents of each batch will be transferred to the GLRV through the use of the AEA system, or equivalent. The GLRV contents will be pH adjusted to 12 with a 50 w% solution of NaOH. The oxidative steps will proceed as outlined previously for the in situ case. Once compliance is achieved[j], the liquid waste residuals from the GLRV will be transferred with the AEA system (or equivalent) to provide feed to a grout mixer/extruder with a capacity of approximately 5 gpm (gallons per minute). 55-gallon steel drums will be used to containerize the grouted waste, and the resulting waste drums will be transferred to, and temporarily stored in, a 30 ft × 30 ft enclosed storage pad awaiting adequate curing. After curing, the waste drums will be transported to ICDF for disposal. See Figure 21 for a process flow diagram of this technology.

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i. This strategy of pretreating the contents of Tank V-9 for the ex situ alternative illustrates a main difference between the in situ alternative and the ex situ alternative. There is much more flexibility in treating the waste ex situ.

j. The same strategy for achieving desired DREs would be used for the ex situ process as was shown for the in situ process:

1. Add a catalyst and increase the temperature (stay below the temperature where the water would be noticeably boiling)
2. Add more oxidant and wait for a specified period
3. Raise the temperature and begin to desorb some of the organic contamination and bypass the condenser for adsorption onto GAC beds.

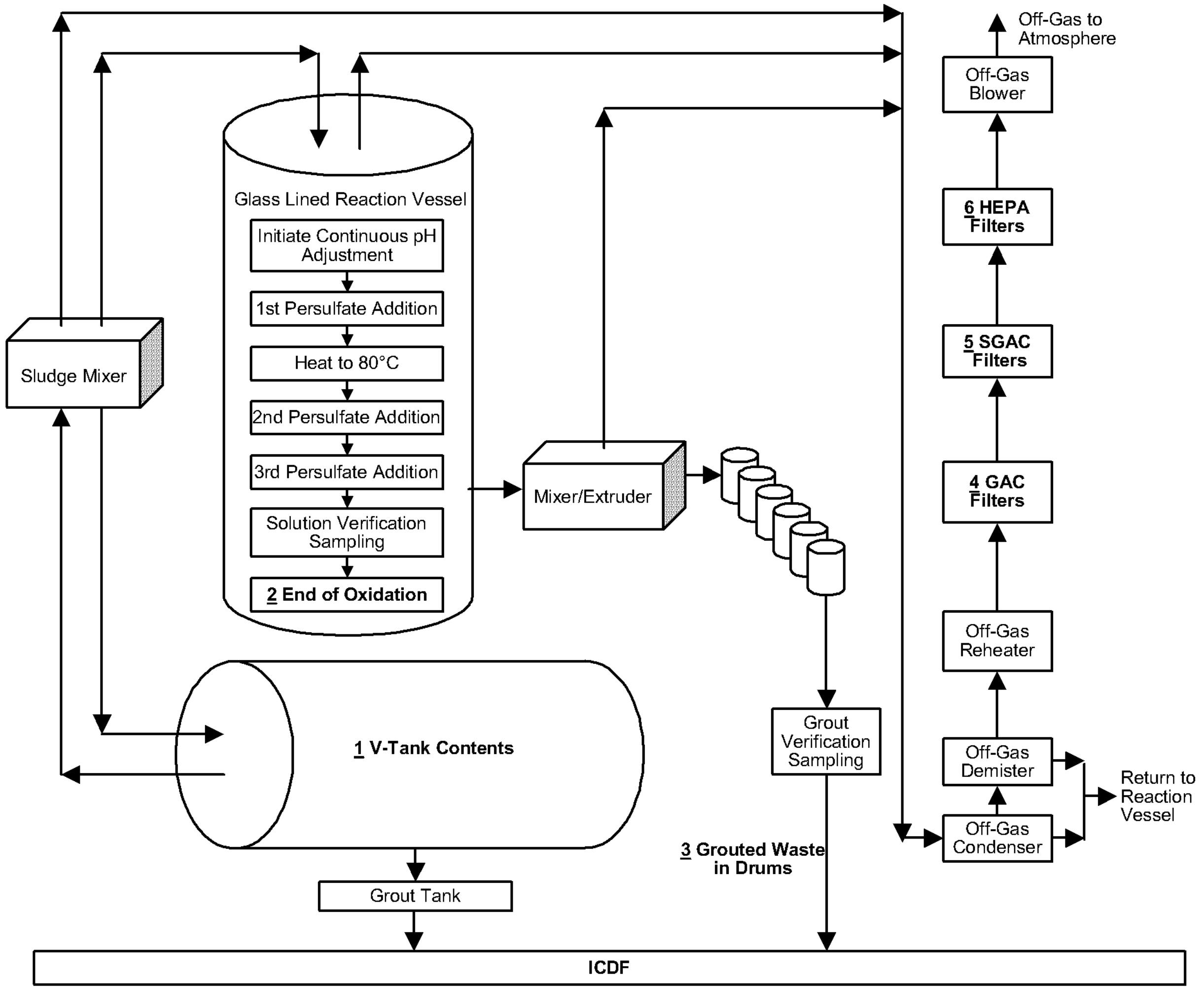

Figure 21. Ex situ chemical oxidation/stabilization overall process flow diagram.

It is estimated that approximately 375 waste drums will be produced in the ex situ operation and that any nongrouted waste handled above ground will require approximately two feet of concrete and half an inch of lead shielding to reduce personnel exposure to 5 mR/hr. Following grouting of the waste, it is estimated that two feet of concrete will be adequate to provide the same exposure reduction (i.e., 5 mR/hr). As a result, all piping from the individual tanks to the GLRV, the GLRV itself, all piping from the GLRV to the grout mixer/extruder, and the mixer/extruder itself, may need to be shielded. The drum filling/handling station, the access to the temporary storage enclosure, and the temporary storage enclosure itself would require only two feet of concrete shielding. It is assumed that the waste drums will need 7 to 10 days to cool before they can be transported and disposed of in the ICDF landfill.

The same off-gas system presented in Section 5.3.2 is proposed for processing and treating potential off-gas constituents.

5.6.1 Disposition Pathways

Following grouting, the resulting 55-gallon containers will be transported to the ICDF. Table 16 lists generated wastes, volumes, and expected disposition, for ES-CO/S. Sufficient grout will be added to the excavated V-tanks to fix any loose contamination and solidify and stabilize the waste residuals. Ultimately, to meet the ICDF WAC, the remaining empty volume in the tanks must be filled. This volume can be filled with contaminated soil from the V-tank AOC or with additional grout.

All of the products and by-products of this process will be targeted for disposal in the ICDF. If the GAC filters are allowed to be classified as debris and if the total organic content is less than 500 ppm, the assumption is that disposal in the ICDF landfill is a possibility (see last bullet of Section 2.1). If the total organic content is greater than 500 ppm, due to lower than expected DREs (or VOC condensate return efficiency) or if the GAC filters are not allowed classification as debris (see Figure 22), the waste will be shipped off-Site for disposal.

Table 16. Summary of waste types, volumes, expected treatments, and expected disposition for ES-CO/S.

Generated Waste Type	Volume	Expected Treatment	Expected Disposition
PRIMARY WASTE	**2469 m^3**		
Grouted Waste (in drums) (Item 3 in PFD)	78 m3	Complete	ICDF
Contaminated Soil/tanks (from V-tank AOC)	2391 m3	Excavate	ICDF
SECONDARY WASTE	**26 m^3**		
GAC filters (Item 4 in PFD)	1 m^3	Macroencapsulate for disposal	ICDF
SGAC filters (Item 5 in PFD)	1 m^3	Macroencapsulate for disposal	ICDF
HEPA filters (Item 6 in PFD)	0.3 m^3	Macroencapsulate for disposal	ICDF
Used PPE, consumable materials, nonrecoverable equipment	24 m^3	Macroencapsulate for disposal	ICDF

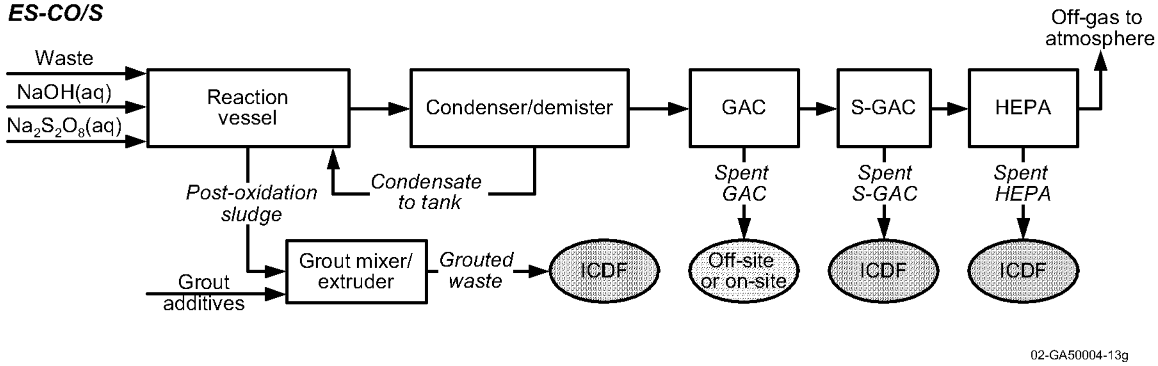

Figure 22. Summary of EX-CO/S waste distribution.

6. SUMMARY

In accordance with the assumptions provided in Section 1 of this report, each of the preconceptual designs presented for the seven identified V-tank waste treatment alternatives meets the threshold criteria within CERCLA. Through identification of the major unit operations, no insurmountable safety or environmental issues were identified. By completing the mass balances for each of the process waste streams and identifying a disposition pathway for each, it was established that compliance with ARARs should be achievable. It should be noted, however, that certain alternatives required acceptance of key assumptions to remain viable. For example, certain risked-based petitions for treatment and disposal must be granted for some alternatives while others assume certain waste repositories will be accepting wastes they are currently not authorized to receive.

Information from these preconceptual designs was used in the Technology Evaluation Report (DOE-ID 2002a) to assist with agency identification of a preferred alternative. In addition, this information will support DOE in subsequent critical decisions on the V-tank project aligned with the INEEL Accelerated Cleanup Project Plan.

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Appendix A

V-Tank Background and Data Discussion

Appendix A
V-Tank Background and Data Information

A1. V-TANK BACKGROUND AND DATA INFORMATION

This appendix presents information pertaining to analytical data of the waste from the V-tanks that will be used for the feasibility studies of the various treatment alternatives. These alternatives are:

- Vitrification (VIT)
  - In situ vitrification (ISV)
  - Ex situ vitrification (ESV)
- Thermal desorption (TD)
  - On-Site desorption with off-Site treatment of off-gas residuals (TD on/off-Site)
  - On-Site desorption with direct treatment of off-gas residuals (TD on-Site)
  - On-Site desorption with off-Site disposal of concentrated solids and off-Site treatment of off-gas residuals (TD off-Site)
- Chemical oxidation/stabilization (CO/S)
  - In situ chemical oxidation followed by stabilization (IS-CO/S)
  - Ex situ chemical oxidation followed by stabilization (ES-CO/S)

The data of interest spans different sampling campaigns. A brief discussion of these campaigns follows.

A2. BACKGROUND

A2.1 Operation of the V-Tanks

The V-tanks were operated in the following configuration:

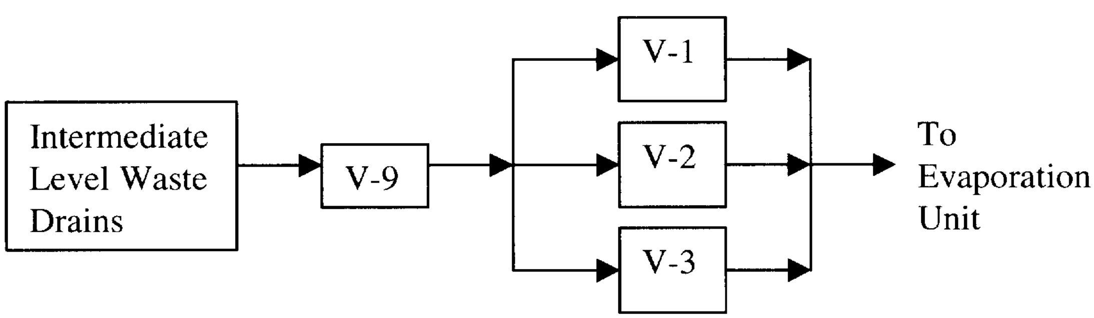

Figure A-1. In-use block flow configuration for the V-tanks.

Waste from operations at TAN-607, TAN-633, and the Initial Engine Test facility were pumped to Tank V-9 (acting as a solids trap) prior to disposition into Tank V-1, V-2, or V-3. Liquid was removed from these tanks and sent to an evaporator (either the TAN-616 evaporator, the PM2A evaporator, or the ICPP evaporator). This activity began in the mid 1950s. In 1968, Tank V-2 was removed from operation due to a large amount of oil that resided on top of the liquid phase. Tanks V-1 and V-3 continued in service until 1985.

A2.2 Sampling of the V-Tanks

Over time, solids accumulated in these tanks. In 1980, a sampling effort was undertaken to determine the composition of the solids in the tanks. The solids were dried, and an x-ray diffraction analysis was performed. The following narrative describes the sampling: (INEL 1996).

In 1980, the tank still bottoms in all three tanks and the oil and water in Tank V-2 were sampled. One of the objectives of the sampling was to obtain full-depth core sediment samples to look for indications of stratification in the still bottoms. To accomplish this, a sample probe and container consisting of a 22-in. tube with a 22-ft-long detachable hollow aluminum handle was constructed. The sample tube was made out of ½-in. Schedule 40 PVC pipe, with a spring-loaded closure plate on the bottom. A PVC pipe cap was used to seal the top of the tube after it was detached from the handle. When the tanks were sampled, tanks V-1 and V-3 were still in use. Tank V-2 had a layer of oil on the liquid, which prevented the liquid wastes in the tank from being removed and processed. The tank was full, but not in use at the time of sampling. Two samples of the sediment were collected from each of the tanks through the 6-in. spare connection (located in approximately the center of the tank). The samples were a thin, black mud. Based on x-ray diffraction analysis and optical examination, the major components of the samples were silicone dioxide (sand, quartz, etc.), with most of the particles less than 10 μm in size. The analyst reported the presence of resin beads and ceramic-like particles (500 to 1000 μm) in all of the samples as well.

Table A-1 shows the results of this sampling effort. The metal analysis was performed on dry solid and is reported on a dry basis.

After the 1980 sampling event, the oil was removed from Tank V-2 (in 1981), and water was removed from the three tanks in 1982. Water continued to be removed from Tanks V1 and V3 from 1982 through 1985 for evaporation. No further additions or removals (i.e., evaporation) have occurred since 1985.[a]

In 1990, two separate liquid campaigns were conducted: one for Tanks V-1 and V-2 and the other for Tank V-3. There is no available information on the method used for collecting the samples, although it is suspected they were collected through the 3-in. or 6-in. connections. All of the analyses were performed on-Site for RCRA hazardous constituents, gamma constituents, and gross alpha/beta.

a. There has been some in-leakage of water into the V-tanks, in particular Tank V-3. This water represents the ground water from rain and snow melt that infiltrated into the tank.

Table A-1. Data from the 1980 sampling effort.

	Tank V-1	Tank V-2	Tank V-3
pH	8.6	9.53	9.57
Undissolved Solids (g/L)	136	53	81
Density (g/ml)	0.9	1.1	1.1
X-Ray Diffraction analysis metals	**Tank V-1 (ppm)**	**Tank V-2 (ppm)**	**Tank V-3 (ppm)**
Ag	20	50	60
Al	6000	10000	8000
B	800	1000	400
Be	400	300	400
Ca	20000	20000	20000
Cr	6000	10000	800
Cu	20	30	8000
Fe	30000	50000	50000
Mg	30000	20000	30000
Mn	8000	2000	10000
Na	1000	600	1000
Ni	500	1000	800
Pb	200	200	200
Si	240000	200000	190000
Sn	70	100	80
Zn	2000	2000	4000
P	110000	120000	130000
Ba	1000	4000	700

In 1993, as part of the OU 1-05 Track 2 investigation, another sampling campaign was performed. Liquid samples were collected from unknown depths in the tanks (V-1, V-2, and V-3) using a peristaltic pump and teflon tubing fastened to a stainless steel pole and inserted into the tank through the open manhole. The sediment samples were collected from the bottom of each tank using a 12-ft. teflon composite liquid waste sampler (COLIWASA). Both types of samples were analyzed for VOCs, metals, gamma radionuclides, uranium, thorium, plutonium, and tritium isotopes, total strontium, gross beta, and miscellaneous information (anions, pH, percent dissolved solids, etc.).

In 1996, another sampling campaign began. This campaign was performed to fill some existing data gaps, such as obtaining values for SVOCs and PCBs. In addition to Tanks V1, V2, and V3, sampling was performed on Tank V-9 to obtain information on its contents.

A3. COMPARISON OF DATA FROM VARIOUS SAMPLING CAMPAIGNS

Each sampling campaign had specific objectives that were different from each other for various reasons. As a result of these differences, no one data set should be used exclusively—a combination of all of the existing data should be used. The following paragraphs discuss the data presented.

A3.1 Metals Data (Bulk and RCRA)

In 1980, the objective of the sampling and analysis effort was to identify the nature of the solids that resided at the bottom of the V-tanks.[b] X-ray diffraction was used to identify bulk metals concentrations within the dried solids. The concentrations were reported on a dry-basis[c]. The sludge phase analyses performed in the 1993 and 1996 sampling campaigns were performed on decanted sludges (1993) and on gravity filtered sludges (1996). An acid digestion method used to determine metals concentration was followed by either inductively coupled plasma atomic (ICP) emission spectroscopy or flame atomic adsorption (AA) spectroscopy. The results were reported on a wet mass without moisture correction.[d]

The main difference in the metals data set, as such, is that by using an acid digestion method, the 1993 and 1996 metals results showed very little silicon. The 1980 metals results report a silicon concentration in the dried solid of 20 to 22%. The acid digestion method is adequate for determining concentrations for most metals, such as RCRA metals, but fails for metals that form highly insoluble species such as SiO_2 or Al_2O_3. For data decisions related to metal analysis, the consensus opinion was to use the bulk metals data from 1980 for metals with concentration greater than 0.5% in the dried solids and the 1996 data for RCRA metals (as characteristic and as underlying hazardous constituents [UHCs]). For

b. The Resource Conservation and Recovery Act (RCRA) guidelines were only beginning to become known by this time – thus hazard identification was not performed.

c. Analysis for metals concentration was the only one performed in the 1980 sampling effort.

d. In 1993, the sludge sample was settled and the aqueous layer decanted away. In 1996, due to the highly disturbed nature of the collection method, the samples had to be gravity filtered to produce similar moisture content of the sludges of the 1993 sampling campaign.

metals characterization in the aqueous phase, data from 1993 was used[e]. Table A-2 provides a summary of the sampling campaigns.

Table A-2. Data choice based on year of sampling campaign.

Analysis	Liquid	Sludge*	Tank V-9 Sludge*
Bulk metals	1993 data	1980 data	1996 data
RCRA metals	1993 data	1996 data	1996 data
Radionuclides	1996 data	1996 data	1996 data
VOC	1993 data	1993 data	1996 data
PCB	1996 data	1996 data	1996 data
SVOC	1996 data	1996 data	1996 data
Miscellaneous: Anions, pH, Total C, etc.	1996 data	1996 data	1996 data
% Solid in Sludge	N/A	1993 data	1996 data

*Denotes reporting data on wet sludge basis.

A3.2 Radiological Data

The radiological data that will be used for these studies are from 1996. A complete nuclide analysis set was performed in that year to examine the V-tank wastes. These results were reported as wet mass without moisture correction.

A3.3 VOC

Volatile organic compound data was obtained for Tanks V-1, V-2, and V-3 from both the 1993 and 1996 campaigns, and only from Tank V-9 in the 1996 campaign. It was determined from conversations with sampling personnel that the 1993 sludge data for VOC was more reliable due to the sampling method employed. As a result, the VOC data from 1993 was used for Tanks V-1, V-2, and V-3. The VOC data from 1996 was used for Tank V-9. All of the VOC data was reported on a wet basis without moisture correction.

A3.4 SVOC

The SVOC results for all of the four tanks are from the 1996 sampling and analysis campaign. The SVOC sludge results were reported on a dry basis with moisture correction.

A3.5 PCB

The PCB results for all four tanks are from the 1996 sampling and analysis campaign. The PCB sludge results were reported on a dry basis with a moisture correction.

e. No metals analysis for the aqueous phases was performed for V-1, V-2, and V-3 in 1996.

A4. IDENTIFICATION OF KEY ANALYTES AND CONTAMINANTS FOR TREATMENT

In order to develop pertinent material balances that will be used as a tool to assist in making a treatment technology choice for the V-tanks, a determination of critical constituents was made. These constituents are separated into two categories:

- Contaminants for Treatment (CFTs)—These are the constituents that have regulatory drivers.
- Key Analytes—These constituents are a subset of the contaminants for treatment and are of a higher priority. A statistical upper confidence limit of 95% was used to ensure any process design could adequately account for these constituents.

These critical parameters are presented in Table A-3. The CFTs cover the regulatory drivers for land disposal (RCRA, ICDF [or other] WACs) and for air emissions (Clean Air Act, MACT). The broad categories of VOCs and SVOCs have individual constituents that are considered underlying hazardous constituents (UHCs) and need to comply with the non-wastewater standards of the Universal Treatment Standards. The key analytes are the constituents that could potentially drive a go/no go scenario for the alternatives, in addition to identifying unit operation steps and equipment sizing per the alternatives' flow sheets.

Table A-3. Listing of CFTs and Key Analytes.

Contaminant for Treatment	Key Analytes	Regulatory Driver (NWW)	Level
Antimony	--------	40 CFR 268.48 (UHC)	1.15 mg/L TCLP
Arsenic	--------	40 CFR 268.40 (D004)	5.0 mg/L TCLP
Barium	--------	40 CFR 268.40 (D005)	21 mg/L TCLP
Beryllium	--------	40 CFR 268.48 (UHC)	1.22 mg/L TCLP
Cadmium	Cadmium	40 CFR 268.40 (D006)	0.11 mg/L TCLP
Chromium	--------	40 CFR 268.40 (D007)	0.60 mg/L TCLP
Cyanide	--------	40 CFR 268.48 (UHC)	30 mg/kg
Lead	--------	40 CFR 268.40 (D008)	0.75 mg/L TCLP
Mercury	Mercury	40 CFR 268.40 (D009)	0.025 mg/L TCLP
Nickel	--------	40 CFR 268.48 (UHC)	11 mg/L TCLP
Silver	--------	40 CFR 268.40 (D011)	0.14 mg/L TCLP
Tetrachloroethylene	--------	40 CFR 268.40 (F001)	6 mg/kg
Trichloroethylene	--------	40 CFR 268.40 (F001)	6 mg/kg
PCBs	PCBs	40 CFR 268.48 (UHC)	10 mg/kg
bis (2-ethylhexyl) phthalate	bis (2-ethylhexyl) phthalate	40 CFR 268.48 (UHC)	28 mg/kg
Chlorides	Chlorides (Total)	MACT/Corrosion Issues	N/A
VOCs (total, other than PCE, TCE)	--------	40 CFR 268.48 (UHC)[a]	N/A
SVOCs (total, other than PCBs and bis (2-ethylhexyl) phthalate)	--------	40 CFR 268.48 (UHC)[a]	N/A
Transuranics (Pu-238, Pu-239/240, Am-241, Cm-243/244, Np-237)	Transuranics (Pu-238, Pu-239/240, Am-241, Cm-243/244, Np-237)	< 10 nCi/g per the ICDF WAC	N/A
Cesium (Cs-137)	Cesium (Cs-137)	WAC (ICDF or other)	N/A
Strontium (Sr-90)	---------	WAC (ICDF or other)	N/A
--------	Total Carbon	None	N/A

.a The VOCs and SVOCs are grouped collectively. The majority of these are below detection limits. For actual treatment, individual species will need to be checked against UTS standards.

A4.1 Identification Of Key Analytes In The Feed

For the various treatment options considered for the V-tanks, certain variables were considered important. These parameters are:

- Cadmium
- Mercury
- Cesium
- Total Carbon
- Transuranic nuclides
- PCBs
- bis (2-ethylhexyl) phthalate
- TCE
- PCE
- Total Chlorides
- Weight Percent Solids.

The following is a description on the significance of these parameters:

Cadmium—Due to its low boiling point (767°C) and a high vapor pressure relative to other metals, cadmium volatilizes readily during thermal operations (such as smelting), then condenses to form fine airborne particles that react almost immediately with oxygen to form cadmium oxide fume. With the potential for high temperatures realized by thermal oxidation and vitrification, cadmium becomes a significant parameter.

Mercury—Mercury is highly volatile, with boiling points of 357°C for elemental mercury and 302°C for mercuric chloride. The purpose of thermal desorption is to intentionally drive mercury from the V-tank solids. Vitrification will equally drive mercury off as well. The amount of mercury in the feed composition is important to predict the amount of mercury in the off-gas for waste disposal issues and to design removal/recovery equipment in the off-gas stream. For CO/S, mercury is considered to be the most problematic of the metals that need to stabilize.

Cesium—Cesium is fairly volatile (671°C boiling point) and may enter the off-gas systems of thermal processes, particularly for vitrification. Cesium produces a high radiation energy and could be problematic in off-gas systems where condensed particulate could be formed.

Total Carbon—The importance of this parameter is that for thermal processes, it is assumed that all of the carbon will be either vaporized as organics or combusted in the presence by the high temperatures. If carbon makes up a slightly significant fraction of the composition, then following a process such as thermal desorption, a lighter residue will be present.

Transuranic nuclides—The amount of transuranic nuclides in the final waste form is important. To be disposed of in the ICDF, the transuranic inventory must be less than 10 nCi/g in the final waste form. Above 100 nCi/g transuranic inventory, the final waste must be disposed of at WIPP. If the transuranic inventory falls between these values, the waste form would be disposed of at the NTS or at Hanford. The processes are to be designed such that the residual waste can be disposed of at the ICDF, wherein the TRU content is less than 10 nCi/g.

PCBs—The importance of this contaminant is the destruction efficiency related to the chemical oxidation process (see Figure A-2). PCBs are very stable chemicals and are strongly partitioned into the solid/heavy oil phase, making wet oxidation slightly problematic. The target goal for PCB is to get to a final waste form of less than 10 mg/kg in the final waste form (RCRA UHC treatment standard). For the thermal process, accounting for PCB in the off-gas is important. For vitrification, destruction to a certain efficiency will be assumed and for thermal desorption, the quantity accumulated is important.

bis (2-ethylhexyl) phthalate—The importance of this contaminant is the destruction efficiency related to the chemical oxidation process (see Figure A-3). This contaminant is in large quantities (as much as 1.05% by weight in dry solids in Tanks V-1 and V-3). This contaminant is regulated as a UHC by RCRA with a nonwastewater treatment standard of 28.

TCE—The importance of this contaminant is the destruction efficiency of the vitrification and chemical oxidation processes relative to the high volatility present. In the off-gas system, partitioning between condenser/scrubber operations versus capture in carbon beds need to be estimated. The target goal for TCE is to get to a final waste form of less than 6 mg/kg in the final waste form (RCRA UTS).

PCE—Same as TCE above.

Total Chlorides—In thermal processes, the chlorides will enter into the off-gas system. For vitrification, both free chlorides and SVOC based chlorides will enter into the off-gas as either Cl_2 or HCl. The importance of chlorides in this instance is related to MACT adherence to the HCl/Cl_2 limit and the design of the off-gas system. The same can be said for thermal desorption, although SVOC based chloride release should not be a problem. For chemical oxidation, the significance of chlorides is the increase of chloride concentration in the slurry due to organic destruction and corrosion issues.

Weight Percent Solids—The significance of this parameter is to the amount of soil addition that is needed to process the waste thermally.

Table A-4 contains a summary of these parameters and their impacts on the treatment options.

Table A-4. Key analytic parameters and their impact on the various treatment flow sheets for V-tank wastes.

TREATMENT OPTIONS FOR THE V-TANK WASTES				
	Vitrification	Thermal Desorption	Thermal Desorption with Off-gas Treatment	Chemical Oxidation/Grout
Cadmium	MACT/Disposal	Disposal	Disposal	Disposal
Mercury	MACT/Disposal	Off-gas Characterization	MACT/Disposal	Disposal
Cesium	Radiation Field/ Disposal	Radiation Field/ Disposal	Radiation Field/ Disposal	Radiation Field/Disposal
Total Carbon	Off-gas Characterization	Off-gas Characterization	Off-gas Characterization	Oxidant Amount
Transuranic nuclides	Disposal	Disposal	Disposal	Disposal
PCBs	Off-gas Characterization	Disposal/Characterizat ion	Off-gas Characterization	Disposal
bis(2-ethylhexyl) phthalate	Disposal/Off-gas Characterization	Disposal/Characterizat ion	Disposal/Off-gas Characterization	Disposal
TCE	Off-gas/ partitioning	Off-gas/partitioning	MACT	Disposal
PCE	Off-gas/ partitioning	Off-gas/partitioning	MACT	Disposal
Total Chlorides	MACT	MACT	MACT	Corrosion
Weight Percent Solids	Disposal/Off-gas	Disposal/Off-gas	Disposal/Off-gas	Disposal

Total mass of key analytes, for the purpose of the material balance analyses, were determined based on the upper 95% confidence level (see Appendix B). This evaluation ensures that each alternative is designed to have a level of robustness such that treatment success can be assured.

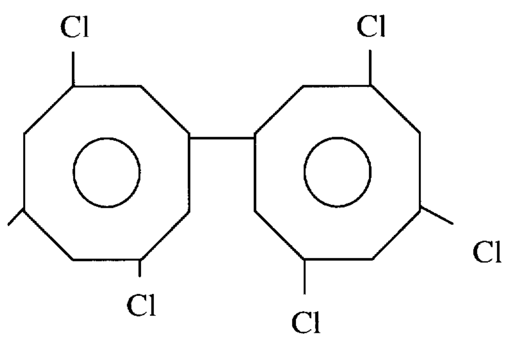

Figure A-2. Representation of a congener of Arochlor 1260 (PCB).

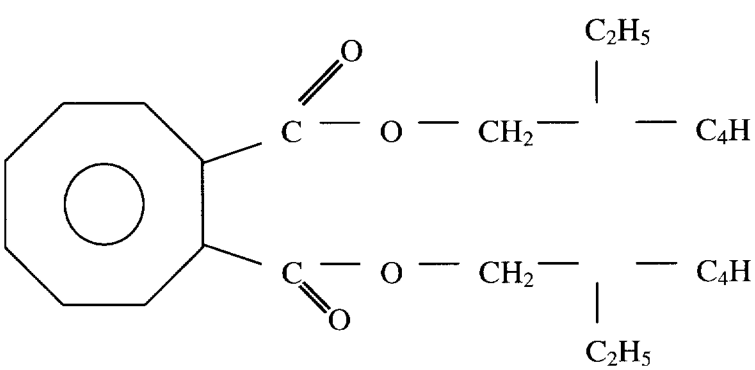

Figure A-3. A representation of bis (2-ethylhexyl) phthalate.

The detailed composition data for V-1, V-2, V-3, V-9, and composite data for all the V-tanks is presented in the accompanying Appendixes A and C Spreadsheets volume.

Summary of Tank V-1

Data Set	Constituent	Slurry Reporting Basis	Slurry UNIT	Slurry Phase (weight fraction) Data pt #1	Data pt #2	Data pt #3	Data pt #4	Data pt #5	AVG Wt Fraction	Sludge Phase Total Constituent, Kg	Liquid Phase (mg/L) Data pt #1	Data pt #2	AVG mg/L	Liquid Phase Total Constituent, Kg	Total Tank Total Constituent, Kg
1980	Al	Dry weight	wt fraction	0.006					6.00E-03	3.37E+00	2.81	3.1	2.96E+00	1.30E-02	3.38E+00
1980	Ca	Dry weight	wt fraction	0.02					2.00E-02	1.12E+01	47.6	47.4	4.75E+01	2.09E-01	1.14E+01
1980	Cr	Dry weight	wt fraction	0.006					6.00E-03	3.37E+00	0.398	0.323	3.61E-01	1.59E-03	3.37E+00
1980	Fe	Dry weight	wt fraction	0.03					3.00E-02	1.68E+01	12	11	1.15E+01	5.07E-02	1.69E+01
1980	Mg	Dry weight	wt fraction	0.03					3.00E-02	1.68E+01	19.7	23.1	2.14E+01	9.43E-02	1.69E+01
1980	Mn	Dry weight	wt fraction	0.008					8.00E-03	4.49E+00	2.78	2.52	2.65E+00	1.17E-02	4.50E+00
1980	Si	Dry weight	wt fraction	0.24					2.40E-01	1.35E+02	16.6	14.9	1.58E+01	6.94E-02	1.35E+02
1980	P	Dry weight	wt fraction	0.11					1.10E-01	6.17E+01	0.40	0.59	4.97E-01	2.19E-03	6.17E+01
1996	Sb	Slurry	wt fraction	1.73E-05	3.00E-05	3.06E-05			2.60E-05	3.29E-02			0.00E+00	0.00E+00	3.29E-02
1996	As	Slurry	wt fraction	1.35E-05	1.88E-05	1.31E-05			1.51E-05	1.91E-02	0.012	0.013	1.25E-02	5.51E-05	1.92E-02
1996	Ba	Slurry	wt fraction	1.39E-04	1.31E-04	3.85E-04			2.18E-04	2.76E-01	0	0	0.00E+00	0.00E+00	2.76E-01
1996	Be	Slurry	wt fraction	1.63E-05	1.86E-05	9.12E-05			4.20E-05	5.32E-02	0	0	0.00E+00	0.00E+00	5.32E-02
1996	**Cd**	Slurry	wt fraction	6.62E-05	7.05E-05	1.70E-04			1.02E-04	1.29E-01	0.049	0.042	4.55E-02	2.00E-04	**2.46E-01**
1996	CN	Slurry	wt fraction						0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	F	Slurry	wt fraction	0	0	0	0	0	0.00E+00	0.00E+00	0	0	0.00E+00	0.00E+00	0.00E+00
1996	Pb	Slurry	wt fraction	1.09E-03	1.13E-03	1.64E-03			1.29E-03	1.63E+00	0.842	0.716	7.79E-01	3.43E-03	1.63E+00
1996	**Hg**	Slurry	wt fraction	1.59E-03	8.30E-04	6.88E-04			1.04E-03	1.31E+00	0.367	0.369	3.68E-01	1.62E-03	**2.24E+00**
1996	Ni	Slurry	wt fraction	3.46E-04	3.52E-04	5.34E-04			4.11E-04	5.20E-01	0.482	0.529	5.06E-01	2.23E-03	5.22E-01
1996	Se	Slurry	wt fraction	0	0	0			0.00E+00	0.00E+00	0	0	0.00E+00	0.00E+00	0.00E+00
1996	Ag	Slurry	wt fraction	8.74E-05	3.60E-07	4.46E-04			1.78E-04	2.25E-01	0.059	0.043	5.10E-02	2.25E-04	2.25E-01
1996	S	Slurry	wt fraction						0.00E+00	0.00E+00	4.27	16.13	1.02E+01	4.49E-02	4.49E-02
1996	Tl	Slurry	wt fraction	0	0	0			0.00E+00	0.00E+00	0	0	0.00E+00	0.00E+00	0.00E+00
1996	V	Slurry	wt fraction	6.40E-06	8.70E-06	9.10E-06			8.07E-06	1.02E-02	0	0	0.00E+00	0.00E+00	1.02E-02
1996	Zn	Slurry	wt fraction	2.47E-02	2.70E-02	1.54E-02			2.24E-02	2.83E+01	60.3	56.1	5.82E+01	2.56E-01	2.86E+01
1996	**Cl**	Slurry	wt fraction	1.53E-04	9.60E-06	7.60E-04	1.23E-04	1.00E-04	2.29E-04	2.90E-01	240	232	2.36E+02	1.04E+00	**1.78E+00**
1996	Na	Slurry	wt fraction	1.01E-03	1.28E-03	5.61E-03	4.78E-03	2.81E-03	3.10E-03	3.92E+00	572	588	5.80E+02	2.56E+00	6.48E+00
1996	K	Slurry	wt fraction	1.05E-03	1.14E-03	7.00E-03	1.11E-03	1.08E-03	2.28E-03	2.88E+00	104	102	1.03E+02	4.54E-01	3.33E+00
1996	**Aroclor-1260**	Dry weight	wt fraction	6.60E-04	5.10E-04	1.50E-04	3.40E-04	3.10E-04	3.94E-04	2.21E-01	0	0	0.00E+00	0.00E+00	**3.31E-01**
1993	TCE	Slurry	wt fraction	2.30E-05	9.10E-07				1.20E-05	2.40E-02	0.16		1.60E-01	7.05E-04	2.47E-02
1993	PCE	Slurry	wt fraction	1.00E-03	1.80E-03				1.40E-03	2.81E+00	0.14		1.40E-01	6.17E-04	2.81E+00
1993	chloromethane	Slurry	wt fraction						0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00
1993	bromomethane	Slurry	wt fraction						0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00
1993	TCA	Slurry	wt fraction	2.20E-06	9.10E-07				1.56E-06	3.12E-03			0.00E+00	0.00E+00	3.12E-03
1993	1,2-dichloroethylene	Slurry	wt fraction								0.058		5.80E-02	2.56E-04	2.56E-04
1993	1,1-dichloroethane	Slurry	wt fraction												0.00E+00
1993	vinyl chloride	Slurry	wt fraction												0.00E+00
1993	methylene chloride	Slurry	wt fraction												
1996	2-methylnaph	Dry weight	wt fraction	0	0	7.60E-06	2.10E-05	2.60E-05	1.09E-05	6.13E-03			0.00E+00	0.00E+00	6.13E-03
1996	1,2-dichloroben	Dry weight	wt fraction							0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	naphthalene	Dry weight	wt fraction						0	0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	**bis(2-ethylhexyl) phthalate**	Dry weight	wt fraction	0.017	0.014	0.0036	0.012	0.0059	1.05E-02	5.89E+00	0.083	0.073	7.80E-02	3.44E-04	**8.99E+00**
1996	1,2,4-trichloroben	Dry weight	wt fraction							0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	1,3-dichloroben	Dry weight	wt fraction							0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	1,4-dichloroben	Dry weight	wt fraction							0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	2,4-dimethylphen	Dry weight	wt fraction							0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	2-methylphenol	Dry weight	wt fraction							0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	4-methylphenol	Dry weight	wt fraction							0.00E+00			0.00E+00	0.00E+00	0.00E+00

Summary of Tank V-1 (Continue)

Data Set	Constituent	Slurry Reporting Basis	Slurry UNIT	Slurry Phase (weight fraction) Data pt #1	Data pt #2	Data pt #3	Data pt #4	Data pt #5	AVG Wt Fraction	Sludge Phase Total Constituent, Kg	Liquid Phase (mg/L) Data pt #1	Data pt #2	AVG mg/L	Liquid Phase Total Constituent, Kg	Total Tank Total Constituent, Kg
1996	di-n-butylphth	Dry weight	wt fraction										0.00E+00	0.00E+00	0.00E+00
1996	phenanthrene	Dry weight	wt fraction						0				0.00E+00	0.00E+00	0.00E+00
1996	pyrene	Dry weight	wt fraction												0.00E+00
1996	phenol	Dry weight	wt fraction										0.00E+00	0.00E+00	0.00E+00
1996	4,6,-dinitro-2-methylphenol	Dry weight	wt fraction												0.00E+00
1996	4-nitrophenol	Dry weight	wt fraction												0.00E+00
1996	di-n-octylphthalate	Dry weight	wt fraction												0.00E+00
1996	tributylphosphate	Dry weight	wt fraction												0.00E+00
1996	**Total Carbon**	Slurry	wt fraction	7.89E-02	8.58E-02	9.29E-02	8.43E-02	7.91E-02	8.42E-02	1.07E+02	66	55	6.05E+01	2.67E-01	**1.48E+02**
				Slurry Phase (nCi/g)					AVG (nCi/g)	Total Constituent, Ci	Liquid Phase (nCi/L)		AVG (nCi/L)	Total Constituent, Ci	Total Tank Total Constituent, Ci
1996	**Pu-238**	Slurry	nCi/g	26.1	26.2	23.7	8.59	10.7	1.91E+01	2.41E-02	0.224		2.24E-01	9.87E-07	2.41E-02
1996	**Pu-239/240**	Slurry	nCi/g	10.8	11.2	11.4	4.6	5.45	8.69E+00	1.10E-02	0.105		1.05E-01	4.63E-07	1.10E-02
1996	**Am-241**	Slurry	nCi/g	28.1	32.8	25.2	9.24	11.7	2.14E+01	2.71E-02	0.197		1.97E-01	8.68E-07	2.71E-02
1996	Cm-242	Slurry	nCi/g	0	0	0	15.2	0	3.04E+00	3.85E-03	0		0.00E+00	0.00E+00	3.85E-03
1996	**Cm-243/244**	Slurry	nCi/g	8.4	9.63	7.26	2.79	3.47	6.31E+00	7.98E-03	0.0642		6.42E-02	2.83E-07	7.98E-03
1996	**Np-237**	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
	Total TRU														**9.94E-02**
1996	U-233/234	Slurry	nCi/g	2.51	1.76	10.4	7.27	4.33	5.25E+00	6.65E-03	18.9		1.89E+01	8.33E-05	6.73E-03
1996	U-235	Slurry	nCi/g	0.078	0.058	0.316	0.214	0.13	1.59E-01	2.01E-04	0.566		5.66E-01	2.49E-06	2.04E-04
1996	U-238	Slurry	nCi/g	0.114	0.065	0.106	0.081	0.067	8.66E-02	1.10E-04	0.21		2.10E-01	9.25E-07	1.10E-04
1996	Sr-90	Slurry	nCi/g	4890	4040	14300	6750	8560	7.71E+03	9.75E+00	2030		2.03E+03	8.94E-03	9.76E+00
1996	Ag-108	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Ag-110	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Ce-144	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Co-58	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Co-60	Slurry	nCi/g	446	151	368	184	67	2.43E+02	3.08E-01	15.5		1.55E+01	6.83E-05	3.08E-01
1996	Cs-134	Slurry	nCi/g	2.9	2.16	1.49	0.5	0.726	1.56E+00	1.97E-03	0		0.00E+00	0.00E+00	1.97E-03
1996	**Cs-137**	Slurry	nCi/g	7260	5910	15800	9960	5100	8.81E+03	1.11E+01	2900		2.90E+03	1.28E-02	**1.72E+01**
1996	Eu-152	Slurry	nCi/g	45.4	52.9	37.3	15.2	25.6	3.53E+01	4.46E-02	0		0.00E+00	0.00E+00	4.46E-02
1996	Eu-154	Slurry	nCi/g	64.3	71.2	53.4	20.3	28.2	4.75E+01	6.01E-02	0		0.00E+00	0.00E+00	6.01E-02
1996	Eu-155	Slurry	nCi/g	0	2.7	0	0	0	5.40E-01	6.83E-04	0		0.00E+00	0.00E+00	6.83E-04
1996	Mn-54	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Nb-95	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Ra-226	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Ru-103	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Ru-106	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Sb-125	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Zn-65	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Zr-95	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	I-129	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Ni-63	Slurry	nCi/g	1980	670	3310	1720	725	1.68E+03	2.13E+00	288		2.88E+02	1.27E-03	2.13E+00
1996	H-3	Slurry	nCi/g							0.00E+00	30400		3.04E+04	1.34E-01	1.34E-01

Summary of Tank V-2

Data Set	Constituent	Slurry Reporting Basis	Slurry UNIT	Slurry Phase (weight fraction) Data pt #1	Data pt #2	Data pt #3	Data pt #4	Data pt #5	AVG Wt Fraction	Sludge Phase Total Constituent, Kg	Liquid Phase (mg/L) Data pt #1	Data pt #2	AVG mg/L	Liquid Phase Total Constituent, Kg	Total Tank Total Constituent, Kg
1980	Al	Dry weight	wt fraction	0.01					0.01	6.79E+00	0	0	0.00E+00	0.00E+00	6.79E+00
1980	Ca	Dry weight	wt fraction	0.02					0.02	1.36E+01	6.49	5.91	6.20E+00	2.67E-02	1.36E+01
1980	Cr	Dry weight	wt fraction	0.01					0.01	6.79E+00	0	0	0.00E+00	0.00E+00	6.79E+00
1980	Fe	Dry weight	wt fraction	0.05					0.05	3.39E+01	0.437	0.464	4.51E-01	1.94E-03	3.39E+01
1980	Mg	Dry weight	wt fraction	0.02					0.02	1.36E+01	14.6	13.1	1.39E+01	5.97E-02	1.36E+01
1980	Mn	Dry weight	wt fraction	0.02					0.02	1.36E+01	0.438	0.475	4.57E-01	1.97E-03	1.36E+01
1980	Si	Dry weight	wt fraction	0.2					0.2	1.36E+02	7.77	6.17	6.97E+00	3.00E-02	1.36E+02
1980	P	Dry weight	wt fraction	0.12					0.12	8.14E+01	7.03	7.77	7.40E+00	3.19E-02	8.15E+01
1996	Sb	Slurry	wt fraction	2.59E-05	2.00E-05				2.30E-05	3.25E-02			0.00E+00	0.00E+00	3.25E-02
1996	As	Slurry	wt fraction	1.85E-05	1.11E-05				1.48E-05	2.10E-02	0.005	0.005	5.00E-03	2.15E-05	2.10E-02
1996	Ba	Slurry	wt fraction	1.87E-04	1.38E-04				1.63E-04	2.30E-01	0	0	0.00E+00	0.00E+00	2.30E-01
1996	Be	Slurry	wt fraction	2.20E-05	1.38E-05				1.79E-05	2.54E-02	0	0	0.00E+00	0.00E+00	2.54E-02
1996	**Cd**	Slurry	wt fraction	1.08E-04	8.67E-05				9.74E-05	1.38E-01	0	0	0.00E+00	0.00E+00	**1.90E-01**
1996	CN	Slurry	wt fraction						0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	F	Slurry	wt fraction	0	0	0	0		0.00E+00	0.00E+00	0	0	0.00E+00	0.00E+00	0.00E+00
1996	Pb	Slurry	wt fraction	1.55E-03	1.05E-03				1.30E-03	1.84E+00	0	0	0.00E+00	0.00E+00	1.84E+00
1996	**Hg**	Slurry	wt fraction	6.12E-04	3.81E-04				4.97E-04	7.03E-01	0	0	0.00E+00	0.00E+00	**1.86E+00**
1996	Ni	Slurry	wt fraction	3.85E-04	2.64E-04				3.25E-04	4.60E-01	0.457	0.411	4.34E-01	1.87E-03	4.62E-01
1996	Se	Slurry	wt fraction	7.80E-06	2.74E-06				5.27E-06	7.47E-03	0	0	0.00E+00	0.00E+00	7.47E-03
1996	Ag	Slurry	wt fraction	1.18E-04	3.15E-04				2.17E-04	3.07E-01	0	0	0.00E+00	0.00E+00	3.07E-01
1996	S	Slurry	wt fraction						0.00E+00	0.00E+00	1.85	6.00	3.93E+00	1.69E-02	1.69E-02
1996	Tl	Slurry	wt fraction	0	0				0.00E+00	0.00E+00	0	0	0.00E+00	0.00E+00	0.00E+00
1996	V	Slurry	wt fraction	0	0				0.00E+00	0.00E+00	0	0	0.00E+00	0.00E+00	0.00E+00
1996	Zn	Slurry	wt fraction	2.13E-03	1.45E-03				1.79E-03	2.54E+00	0.164	0.129	1.47E-01	6.31E-04	2.54E+00
1996	**Cl**	Slurry	wt fraction	1.36E-04	7.32E-05	4.75E-05	4.39E-05		7.52E-05	1.06E-01	136	102	1.19E+02	5.13E-01	**1.24E+00**
1996	Na	Slurry	wt fraction	1.74E-03	1.27E-03				1.51E-03	2.13E+00	408	407	4.08E+02	1.76E+00	3.89E+00
1996	K	Slurry	wt fraction	2.67E-03	1.77E-03				2.22E-03	3.14E+00	276	272	2.74E+02	1.18E+00	4.33E+00
1996	**Aroclor-1260**	Dry weight	wt fraction	2.00E-04	2.50E-04	1.60E-04	2.60E-04		2.18E-04	1.48E-01	0	0	0.00E+00	0.00E+00	**1.91E-01**
1993	TCE	Slurry	wt fraction	6.00E-07	6.80E-07				6.40E-07	1.13E-03	0.3		3.00E-01	1.29E-03	2.42E-03
1993	PCE	Slurry	wt fraction	4.40E-04	5.10E-04				4.75E-04	8.38E-01			0.00E+00	0.00E+00	8.38E-01
1993	chloromethane	Slurry	wt fraction							0.00E+00			0.00E+00	0.00E+00	0.00E+00
1993	bromomethane	Slurry	wt fraction							0.00E+00			0.00E+00	0.00E+00	0.00E+00
1993	TCA	Slurry	wt fraction	6.00E-07	6.80E-07				6.40E-07	1.13E-03			0.00E+00	0.00E+00	1.13E-03
1993	1,2-dichloroethylene	Slurry	wt fraction						0.00E+00	0.00E+00	0.37		3.70E-01	1.59E-03	1.59E-03
1993	1,1-dichloroethane	Slurry	wt fraction							0.00E+00	0.036		3.60E-02	1.55E-04	1.55E-04
1993	vinyl chloride	Slurry	wt fraction							0.00E+00	0.02		2.00E-02	8.61E-05	8.61E-05
1993	methylene chloride	Slurry	wt fraction							0.00E+00					0.00E+00
1996	2-methylnaph	Dry weight	wt fraction	1.20E-05	3.80E-05	5.70E-05	3.80E-05		3.63E-05	2.46E-02			0.00E+00	0.00E+00	2.46E-02
1996	1,2-dichloroben	Dry weight	wt fraction	0	3.00E-05	2.40E-05	2.20E-05		1.90E-05	1.29E-02	0	0.057	2.85E-02	1.23E-04	1.30E-02
1996	naphthalene	Dry weight	wt fraction	0	0	1.40E-05	0		3.50E-06	2.37E-03			0.00E+00	0.00E+00	2.37E-03
1996	**bis(2-ethylhexyl) phthalate**	Dry weight	wt fraction	0.007	0.011	1.50E-03	1.50E-03		5.25E-03	3.56E+00	0.086	0.2	1.43E-01	6.16E-04	**7.38E+00**
1996	1,2,4-trichloroben	Dry weight	wt fraction						0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	1,3-dichloroben	Dry weight	wt fraction						0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	1,4-dichloroben	Dry weight	wt fraction						0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	2,4-dimethylphen	Dry weight	wt fraction						0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	2-methylphenol	Dry weight	wt fraction						0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	4-methylphenol	Dry weight	wt fraction						0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00

Summary of Tank V-2 (Continue)

Data Set	Constituent	Slurry Reporting Basis	Slurry UNIT	Slurry Phase (weight fraction) Data pt #1	Data pt #2	Data pt #3	Data pt #4	Data pt #5	AVG Wt Fractior	Sludge Phase Total Constituent, Kg	Liquid Phase (mg/L) Data pt #1	Data pt #2	AVG mg/L	Liquid Phase Total Constituent, Kg	Total Tank Total Constituent, Kg
1996	di-n-butylphth	Dry weight	wt fraction						0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	phenanthrene	Dry weight	wt fraction						0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	pyrene	Dry weight	wt fraction						0.00E+00	0.00E+00	0	0.052	2.60E-02	1.12E-04	1.12E-04
1996	phenol	Dry weight	wt fraction	0.00E+00	0.00E+00	0.00E+00	0.00E+00		0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	4,6,-dinitro-2-methylphenol	Dry weight	wt fraction												0.00E+00
1996	4-nitrophenol	Dry weight	wt fraction												0.00E+00
1996	di-n-octylphthalate	Dry weight	wt fraction												0.00E+00
1996	tributylphosphate	Dry weight	wt fraction												0.00E+00
1996	**Total Carbon**	Slurry	wt fraction	1.84E-01	7.98E-02	2.00E-01	1.07E-01		1.43E-01	2.02E+02	105		1.05E+02	4.52E-01	**2.99E+02**
									AVG (nCi/(	Total Constituent, Ci	Liquid Phase (nCi/L)		AVG (nCi/L	Total Constituent, Ci	Total Tank Total Constituent, Ci
1996	**Pu-238**	Slurry	nCi/g	5.69	4.44	13.9	7.54		7.89E+00	1.12E-02	0.475		4.75E-01	2.05E-06	1.12E-02
1996	**Pu-239/240**	Slurry	nCi/g	8.26	7.5	6.15	4.73		6.66E+00	9.43E-03	0.283		2.83E-01	1.22E-06	9.44E-03
1996	**Am-241**	Slurry	nCi/g	3.52	2.68	2.5	1.23		2.48E+00	3.52E-03	0.059		5.90E-02	2.54E-07	3.52E-03
1996	Cm-242	Slurry	nCi/g	0.003	0.002	0.0095	0.003		4.38E-03	6.20E-06	0		0.00E+00	0.00E+00	6.20E-06
1996	**Cm-243/244**	Slurry	nCi/g	0.16	0.126	0.117	0.244		1.62E-01	2.29E-04	0.0162		1.62E-02	6.98E-08	2.29E-04
1996	**Np-237**	Slurry	nCi/g	0	0	0	0		0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
	Total TRU								0.00E+00						**3.11E-02**
1996	U-233/234	Slurry	nCi/g	3.79	2.66	3.15	3.35		3.24E+00	4.59E-03	38.6		3.86E+01	1.66E-04	4.75E-03
1996	U-235	Slurry	nCi/g	0.113	0.081	0.1	0.102		9.90E-02	1.40E-04	1.6		1.60E+00	6.89E-06	1.47E-04
1996	U-238	Slurry	nCi/g	0.131	0.051	0.097	0.075		8.85E-02	1.25E-04	0.499		4.99E-01	2.15E-06	1.28E-04
1996	Sr-90	Slurry	nCi/g	16500	11500	10700	16100		1.37E+04	1.94E+01	4900		4.90E+03	2.11E-02	1.94E+01
1996	Ag-108	Slurry	nCi/g	0	0.753	0	0		1.88E-01	2.67E-04	0		0.00E+00	0.00E+00	2.67E-04
1996	Ag-110	Slurry	nCi/g	0	0	0	0		0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Ce-144	Slurry	nCi/g	0	0	0	0		0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Co-58	Slurry	nCi/g	0	0	0	0		0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Co-60	Slurry	nCi/g	705	156	138	75.8		2.69E+02	3.81E-01	13		1.30E+01	5.60E-05	3.81E-01
1996	Cs-134	Slurry	nCi/g	0	0.316	0	0		7.90E-02	1.12E-04	0		0.00E+00	0.00E+00	1.12E-04
1996	**Cs-137**	Slurry	nCi/g	14100	6330	5660	4870		7.74E+03	1.10E+01	13500		1.35E+04	5.81E-02	**1.81E+01**
1996	Eu-152	Slurry	nCi/g	48.6	2.95	3.03	9.93		1.61E+01	2.28E-02	0		0.00E+00	0.00E+00	2.28E-02
1996	Eu-154	Slurry	nCi/g	33.4	24.4	20.2	14.6		2.32E+01	3.28E-02	0		0.00E+00	0.00E+00	3.28E-02
1996	Eu-155	Slurry	nCi/g	0	2.58	2.87	0		1.36E+00	1.93E-03	0		0.00E+00	0.00E+00	1.93E-03
1996	Mn-54	Slurry	nCi/g	0	0	0	0		0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Nb-95	Slurry	nCi/g	0	0	0	0		0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Ra-226	Slurry	nCi/g	0	0	0	0		0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Ru-103	Slurry	nCi/g	0	0	0	0		0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Ru-106	Slurry	nCi/g	0	0	0	0		0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Sb-125	Slurry	nCi/g	0	0	0	0		0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Zn-65	Slurry	nCi/g	0	0	0	0		0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Zr-95	Slurry	nCi/g	0	0	0	0		0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	I-129	Slurry	nCi/g	0	0	0	0		0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Ni-63	Slurry	nCi/g	1750	557	804	569		9.20E+02	1.30E+00	448		4.48E+02	1.93E-03	1.31E+00
1996	H-3	Slurry	nCi/g						0.00E+00	0.00E+00	102000		1.02E+05	4.39E-01	4.39E-01

Summary of Tank V-3

		Slurry	Slurry	Slurry Phase (weight fraction)					AVG	Sludge Phase	Liquid Phase (mg/L)		AVG	Liquid Phase	Total Tank
Data Set	Constituent	Reporting Basis	UNIT	Data pt #1	Data pt #2	Data pt #3	Data pt #4	Data pt #5	Wt Fraction	Total Constituent, Kg	Data pt #1	Data pt #2	mg/L	Total Constituent, Kg	Total Constituent, Kg
1980	Al	Dry weight	wt fraction	0.008					0.008	8.12E+00	0	0	0.00E+00	0.00E+00	8.12E+00
1980	Ca	Dry weight	wt fraction	0.02					0.02	2.03E+01	51.4	49	5.02E+01	3.16E-01	2.06E+01
1980	Cr	Dry weight	wt fraction	0.0008					0.0008	8.12E-01	0	0	0.00E+00	0.00E+00	8.12E-01
1980	Fe	Dry weight	wt fraction	0.05					0.05	5.07E+01	0	0	0.00E+00	0.00E+00	5.07E+01
1980	Mg	Dry weight	wt fraction	0.03					0.03	3.04E+01	17.9	14.3	1.61E+01	1.01E-01	3.05E+01
1980	Mn	Dry weight	wt fraction	0.01					0.01	1.01E+01	0.746	0.765	7.56E-01	4.75E-03	1.02E+01
1980	Si	Dry weight	wt fraction	0.19					0.19	1.93E+02	7.46	6.48	6.97E+00	4.38E-02	1.93E+02
1980	P	Dry weight	wt fraction	0.13					0.13	1.32E+02	0.84	0	4.18E-01	2.63E-03	1.32E+02
1996	Sb	Slurry	wt fraction	1.10E-05	1.50E-05	1.15E-05	1.79E-05		1.39E-05	3.02E-02			0.00E+00	0.00E+00	3.02E-02
1996	As	Slurry	wt fraction	1.90E-05	1.22E-05	7.68E-06	1.08E-05		1.24E-05	2.71E-02	0	0	0.00E+00	0.00E+00	2.71E-02
1996	Ba	Slurry	wt fraction	1.48E-04	1.58E-04	1.84E-04	1.75E-04		1.66E-04	3.62E-01	0	0	0.00E+00	0.00E+00	3.62E-01
1996	Be	Slurry	wt fraction	1.51E-05	1.79E-05	2.34E-05	2.97E-05		2.15E-05	4.69E-02	0	0	0.00E+00	0.00E+00	4.69E-02
1996	**Cd**	Slurry	wt fraction	7.18E-05	8.03E-05	6.13E-05	8.14E-05		7.37E-05	1.61E-01	0	0	0.00E+00	0.00E+00	**2.02E-01**
1996	CN	Slurry	wt fraction						0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	F	Slurry	wt fraction	0	0	0	0		0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Pb	Slurry	wt fraction	1.37E-03	1.21E-03	6.96E-04	9.30E-04		1.05E-03	2.29E+00	0.033	0.068	5.05E-02	3.17E-04	2.29E+00
1996	**Hg**	Slurry	wt fraction	1.39E-03	8.20E-04	3.45E-04	4.29E-04		7.46E-04	1.62E+00	0	0	0.00E+00	0.00E+00	**2.93E+00**
1996	Ni	Slurry	wt fraction	1.98E-04	4.18E-04	3.34E-04	4.25E-04		3.44E-04	7.49E-01	0.185	0.183	1.84E-01	1.16E-03	7.50E-01
1996	Se	Slurry	wt fraction	0	0	0	0		0.00E+00	0.00E+00	0	0	0.00E+00	0.00E+00	0.00E+00
1996	Ag	Slurry	wt fraction	4.28E-05	4.87E-05	1.98E-04	1.13E-04		1.01E-04	2.19E-01	0	0	0.00E+00	0.00E+00	2.19E-01
1996	S	Slurry	wt fraction						0.00E+00	0.00E+00	5.23		2.62E+00	1.65E-02	1.65E-02
1996	Tl	Slurry	wt fraction	0	0	0	0		0.00E+00	0.00E+00	0	0	0.00E+00	0.00E+00	0.00E+00
1996	V	Slurry	wt fraction	1.08E-05	6.43E-06	2.06E-06	5.78E-06		6.27E-06	1.37E-02	0	0	0.00E+00	0.00E+00	1.37E-02
1996	Zn	Slurry	wt fraction	9.73E-03	5.88E-03	2.56E-03	3.44E-03		5.40E-03	1.18E+01	0.964	0.724	8.44E-01	5.31E-03	1.18E+01
1996	**Cl**	Slurry	wt fraction	6.43E-05	6.01E-05	5.48E-05	5.56E-05		5.87E-05	1.28E-01	76.2		7.62E+01	4.79E-01	**8.94E-01**
1996	Na	Slurry	wt fraction	4.53E-04	1.07E-03	2.01E-03	2.44E-03		1.49E-03	3.25E+00	167	162	1.65E+02	1.03E+00	4.29E+00
1996	K	Slurry	wt fraction	8.11E-04	8.22E-04	1.08E-03	1.35E-03		1.02E-03	2.21E+00	51.7	47.7	4.97E+01	3.12E-01	2.52E+00
1996	**Aroclor-1260**	Dry weight	wt fraction	3.70E-04	4.00E-04	2.10E-04	2.60E-04		3.10E-04	3.15E-01	0		0.00E+00	0.00E+00	**4.60E-01**
1993	TCE	Slurry	wt fraction	6.30E-07	6.30E-07				6.30E-07	1.58E-03	0.2		2.00E-01	1.26E-03	2.84E-03
1993	PCE	Slurry	wt fraction	4.30E-04	4.80E-04				4.55E-04	1.14E+00			0.00E+00	0.00E+00	1.14E+00
1993	chloromethane	Slurry	wt fraction							0.00E+00			0.00E+00	0.00E+00	0.00E+00
1993	bromomethane	Slurry	wt fraction							0.00E+00			0.00E+00	0.00E+00	0.00E+00
1993	TCA	Slurry	wt fraction	6.30E-07	6.00E-07				6.15E-07	1.55E-03			0.00E+00	0.00E+00	1.55E-03
1993	1,2-dichloroethylene	Slurry	wt fraction						0.00E+00	0.00E+00	0.2		2.00E-01	1.26E-03	1.26E-03
1993	1,1-dichloroethane	Slurry	wt fraction						0.00E+00	0.00E+00	0.019		1.90E-02	1.19E-04	1.19E-04
1993	vinyl chloride	Slurry	wt fraction							0.00E+00	0.011		1.10E-02	6.92E-05	6.92E-05
1993	methylene chloride	Slurry	wt fraction							0.00E+00					0.00E+00
1996	2-methylnaph	Dry weight	wt fraction	1.60E-05	9.90E-06	3.20E-05	1.50E-05		1.82E-05	1.85E-02			0.00E+00	0.00E+00	1.85E-02
1996	1,2-dichloroben	Dry weight	wt fraction	1.60E-05	1.10E-05	5.00E-05	2.60E-05		2.58E-05	2.61E-02			0.00E+00	0.00E+00	2.61E-02
1996	naphthalene	Dry weight	wt fraction						0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	**bis(2-ethylhexyl) phthalate**	Dry weight	wt fraction	0.0096	0.012	0.012	0.0084		1.05E-02	1.07E+01	0.1		1.00E-01	6.29E-04	**1.37E+01**
1996	1,2,4-trichloroben	Dry weight	wt fraction							0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	1,3-dichloroben	Dry weight	wt fraction							0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	1,4-dichloroben	Dry weight	wt fraction							0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	2,4-dimethylphen	Dry weight	wt fraction							0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	2-methylphenol	Dry weight	wt fraction						0	0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	4-methylphenol	Dry weight	wt fraction							0.00E+00			0.00E+00	0.00E+00	0.00E+00

Summary of Tank V-3 (Continue)

Data Set	Constituent	Slurry Reporting Basis	Slurry UNIT	Slurry Phase (weight fraction) Data pt #1	Data pt #2	Data pt #3	Data pt #4	Data pt #5	AVG Wt Fraction	Sludge Phase Total Constituent, Kg	Liquid Phase (mg/L) Data pt #1	Data pt #2	AVG mg/L	Liquid Phase Total Constituent, Kg	Total Tank Total Constituent, Kg
1996	di-n-butylphth	Dry weight	wt fraction						0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	phenanthrene	Dry weight	wt fraction						0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	pyrene	Dry weight	wt fraction						0.00E+00	0.00E+00	0.063		6.30E-02	3.96E-04	3.96E-04
1996	phenol	Dry weight	wt fraction						0.00E+00	0.00E+00			0.00E+00	0.00E+00	0.00E+00
1996	4,6,-dinitro-2-methylphenol	Dry weight	wt fraction						0.00E+00	0.00E+00					0.00E+00
1996	4-nitrophenol	Dry weight	wt fraction						0.00E+00	0.00E+00					0.00E+00
1996	di-n-octylphthalate	Dry weight	wt fraction						0.00E+00	0.00E+00					0.00E+00
1996	tributylphosphate	Dry weight	wt fraction						0.00E+00	0.00E+00					0.00E+00
1996	**Total Carbon**	Slurry	wt fraction	9.37E-02	1.10E-01	1.13E-01	1.44E-01		1.15E-01	2.51E+02	35		3.50E+01	2.20E-01	**3.45E+02**
									AVG (nCi/g)	Total Constituent, Ci	Liquid Phase (nCi/L)		AVG (nCi/L)	Total Constituent, Ci	Total Tank Total Constituent, Ci
1996	**Pu-238**	Slurry	nCi/g	15.3	14.6	11.8	14.2	10.8	1.33E+01	2.91E-02	0.038		3.80E-02	2.39E-07	2.91E-02
1996	**Pu-239/240**	Slurry	nCi/g	10	7.44	5.37	6.84	4.81	6.89E+00	1.50E-02	0.0197		1.97E-02	1.24E-07	1.50E-02
1996	**Am-241**	Slurry	nCi/g	11.5	7.66	4.84	6.18	5.62	7.16E+00	1.56E-02	0.0318		3.18E-02	2.00E-07	1.56E-02
1996	Cm-242	Slurry	nCi/g	0	0.0199	0.0132	0	0	6.62E-03	1.44E-05	0		0.00E+00	0.00E+00	1.44E-05
1996	**Cm-243/244**	Slurry	nCi/g	3.69	2.07	1.14	1.59	1.57	2.01E+00	4.38E-03	0		0.00E+00	0.00E+00	4.38E-03
1996	**Np-237**	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
	Total TRU														**8.36E-02**
1996	U-233/234	Slurry	nCi/g	1.38	1.11	2.43	2.18	4.06	2.23E+00	4.86E-03	13.3		1.33E+01	8.36E-05	4.94E-03
1996	U-235	Slurry	nCi/g	0.05	0.038	0.079	0.069	0.128	7.28E-02	1.59E-04	0.4		4.00E-01	2.51E-06	1.61E-04
1996	U-238	Slurry	nCi/g	0.065	0.051	0.079	0.061	0.085	6.82E-02	1.49E-04	0.135		1.35E-01	8.49E-07	1.49E-04
1996	Sr-90	Slurry	nCi/g	6210	10200	23200	44500	24000	2.16E+04	4.71E+01	12300		1.23E+04	7.73E-02	4.72E+01
1996	Ag-108	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Ag-110	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Ce-144	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Co-58	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0		0.00E+00	0.00E+00	0.00E+00
1996	Co-60	Slurry	nCi/g	184	321	128	223	80.5	1.87E+02	4.08E-01	14.8	4.48	9.64E+00	6.06E-05	4.08E-01
1996	Cs-134	Slurry	nCi/g	2.64	2.37	0	0.897	1.09	1.40E+00	3.05E-03	0	0.449	2.25E-01	1.41E-06	3.05E-03
1996	**Cs-137**	Slurry	nCi/g	6810	7450	8050	6630	9050	7.60E+03	1.65E+01	4230	1560	2.90E+03	1.82E-02	**2.23E+01**
1996	Eu-152	Slurry	nCi/g	28.4	29.3	8.47	12.8	12.5	1.83E+01	3.98E-02	0	0	0.00E+00	0.00E+00	3.98E-02
1996	Eu-154	Slurry	nCi/g	37.9	33.8	26.3	30.6	28.5	3.14E+01	6.84E-02	0	0	0.00E+00	0.00E+00	6.84E-02
1996	Eu-155	Slurry	nCi/g	2.32	0	0	0	0	4.64E-01	1.01E-03	0	0	0.00E+00	0.00E+00	1.01E-03
1996	Mn-54	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0	0	0.00E+00	0.00E+00	0.00E+00
1996	Nb-95	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0	0	0.00E+00	0.00E+00	0.00E+00
1996	Ra-226	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0	0	0.00E+00	0.00E+00	0.00E+00
1996	Ru-103	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0	0	0.00E+00	0.00E+00	0.00E+00
1996	Ru-106	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0	0	0.00E+00	0.00E+00	0.00E+00
1996	Sb-125	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0	0	0.00E+00	0.00E+00	0.00E+00
1996	Zn-65	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0	0	0.00E+00	0.00E+00	0.00E+00
1996	Zr-95	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0	0	0.00E+00	0.00E+00	0.00E+00
1996	I-129	Slurry	nCi/g	0	0	0	0	0	0.00E+00	0.00E+00	0	0	0.00E+00	0.00E+00	0.00E+00
1996	Ni-63	Slurry	nCi/g	1770	1480	969	111	441	9.54E+02	2.08E+00	205		2.05E+02	1.29E-03	2.08E+00
1996	H-3	Slurry	nCi/g								6090		6.09E+03	3.83E-02	3.83E-02

Summary of Tank V-9

Data Set	Constituent	Slurry Reporting Basis	Slurry UNIT	Slurry Phase (weight fraction) Data pt #1	Data pt #2	Data pt #3	Data pt #4	Data pt #5	AVG Wt Fraction	Sludge Phase Total Constituent, Kg	Liquid Phase mg/L Data pt #1	AVG mg/L	Liquid Phase Total Constituent, Kg	Total Tank Total Constituent, Kg
1980	Al	Dry weight	wt fraction	0.008					0.008	3.58E+00	0	0	0.00E+00	3.58E+00
1980	Ca	Dry weight	wt fraction	0.02					0.02	8.95E+00	90.6	90.6	2.40E-02	8.97E+00
1980	Cr	Dry weight	wt fraction	0.0056					0.0056	2.51E+00	1.46	1.46	3.87E-04	2.51E+00
1980	Fe	Dry weight	wt fraction	0.043333					0.043333	1.94E+01	17.9	17.9	4.74E-03	1.94E+01
1980	Mg	Dry weight	wt fraction	0.026667					0.026667	1.19E+01	208	208	5.51E-02	1.20E+01
1980	Mn	Dry weight	wt fraction	0.012667					0.012667	5.67E+00	23.5	23.5	6.23E-03	5.67E+00
1980	Si	Dry weight	wt fraction	0.21					0.21	9.40E+01	25	25	6.62E-03	9.40E+01
1980	P	Dry weight	wt fraction	0.12					0.12	5.37E+01	0	0	0.00E+00	5.37E+01
1996	Sb	Slurry	wt fraction	6.40E-06	2.22E-05				1.43E-05	1.52E-02	0	0	0.00E+00	1.52E-02
1996	As	Slurry	wt fraction	0	0				0.00E+00	0.00E+00	0	0	0.00E+00	0.00E+00
1996	Ba	Slurry	wt fraction	2.32E-04	5.15E-04				3.74E-04	3.98E-01	1.02	1.02	2.70E-04	3.98E-01
1996	Be	Slurry	wt fraction	2.46E-05	2.57E-05				2.52E-05	2.68E-02	0.065	0.065	1.72E-05	2.68E-02
1996	**Cd**	Slurry	wt fraction	2.25E-05	3.09E-05				2.67E-05	2.84E-02	1.9	1.9	5.03E-04	**4.49E-02**
1996	CN	Slurry	wt fraction						0.00E+00	0.00E+00			0.00E+00	0.00E+00
1996	F	Slurry	wt fraction						0.00E+00	0.00E+00	0	0	0.00E+00	0.00E+00
1996	Pb	Slurry	wt fraction	5.40E-04	5.92E-04				5.66E-04	6.03E-01	0.942	0.942	2.50E-04	6.03E-01
1996	**Hg**	Slurry	wt fraction	2.05E-03	2.11E-03				2.08E-03	2.22E+00	0.563	0.563	1.49E-04	**2.63E+00**
1996	Ni	Slurry	wt fraction	3.54E-04	4.35E-04				3.95E-04	4.20E-01	13.8	13.8	3.66E-03	4.24E-01
1996	Se	Slurry	wt fraction	0	0				0.00E+00	0.00E+00	0	0	0.00E+00	0.00E+00
1996	Ag	Slurry	wt fraction	6.57E-04	6.46E-04				6.52E-04	6.94E-01	0	0	0.00E+00	6.94E-01
1996	S	Slurry	wt fraction						0.00E+00	0.00E+00	0.10	0.10	2.56E-05	2.56E-05
1996	Tl	Slurry	wt fraction	0	7.80E-06				3.90E-06	4.16E-03	0	0	0.00E+00	4.16E-03
1996	V	Slurry	wt fraction	5.40E-06	6.80E-06				6.10E-06	6.50E-03	0	0	0.00E+00	6.50E-03
1996	Zn	Slurry	wt fraction	1.79E-03	1.71E-03				1.75E-03	1.86E+00	18.2	18.2	4.82E-03	1.87E+00
1996	**Cl**	Slurry	wt fraction	4.83E-04	5.03E-04				4.93E-04	5.25E-01	10.9	10.9	2.89E-03	**1.18E+00**
1996	Na	Slurry	wt fraction	1.95E-03	1.28E-03				1.62E-03	1.72E+00	3150	3150	8.35E-01	2.56E+00
1996	K	Slurry	wt fraction	1.03E-02	6.87E-03				8.59E-03	9.15E+00	8340	8340	2.21E+00	1.14E+01
1996	**Aroclor-1260**	Dry weight	wt fraction	3.10E-04	2.60E-04				2.85E-04	1.28E-01	0.036	0.036	9.54E-06	**2.05E-01**
1993	TCE	Slurry	wt fraction	1.40E-02	2.20E-02				1.80E-02	1.92E+01	410	410	1.09E-01	1.93E+01
1993	PCE	Slurry	wt fraction	4.60E-04	6.00E-04				5.30E-04	5.65E-01			0.00E+00	5.65E-01
1993	chloromethane	Slurry	wt fraction	5.90E-05	8.00E-05				6.95E-05	7.41E-02			0.00E+00	7.41E-02
1993	bromomethane	Slurry	wt fraction	1.20E-04	1.40E-04				1.30E-04	1.39E-01			0.00E+00	1.39E-01
1993	TCA	Slurry	wt fraction	1.80E-03	2.60E-03				2.20E-03	2.34E+00	58	58	1.54E-02	2.36E+00
1993	1,2-dichloroethylene	Slurry	wt fraction						0.00E+00				0.00E+00	0.00E+00
1993	1,1-dichloroethane	Slurry	wt fraction						0.00E+00				0.00E+00	0.00E+00
1993	vinyl chloride	Slurry	wt fraction						0.00E+00				0.00E+00	0.00E+00
1993	methylene chloride	Slurry	wt fraction								59	59	1.56E-02	1.56E-02
1996	2-methylnaph	Dry weight	wt fraction	1.10E-04	1.00E-04				1.05E-04	4.70E-02			0.00E+00	4.70E-02
1996	1,2-dichloroben	Dry weight	wt fraction	3.50E-04	2.80E-04				3.15E-04	1.41E-01	0.21	0.21	5.56E-05	1.41E-01
1996	naphthalene	Dry weight	wt fraction	4.40E-05	3.80E-05				4.10E-05	1.83E-02			0.00E+00	1.83E-02
1996	**bis(2-ethylhexyl) phthalate**	Dry weight	wt fraction	1.10E-03	9.50E-04				1.03E-03	4.59E-01	0.038	0.038	1.01E-05	**7.35E-01**
1996	1,2,4-trichloroben	Dry weight	wt fraction	3.20E-05	2.60E-05				2.90E-05	1.30E-02			0.00E+00	1.30E-02
1996	1,3-dichloroben	Dry weight	wt fraction	1.60E-05	1.30E-05				1.45E-05	6.49E-03			0.00E+00	6.49E-03
1996	1,4-dichloroben	Dry weight	wt fraction	9.00E-05	7.30E-05				8.15E-05	3.65E-02	0.049	0.049	1.30E-05	3.65E-02
1996	2,4-dimethylphen	Dry weight	wt fraction	2.70E-04	2.60E-04				2.65E-04	1.19E-01	0.079	0.079	2.09E-05	1.19E-01
1996	2-methylphenol	Dry weight	wt fraction	4.90E-04	5.00E-04				4.95E-04	2.22E-01	0.83	0.83	2.20E-04	2.22E-01
1996	4-methylphenol	Dry weight	wt fraction	2.60E-04	2.60E-04				2.60E-04	1.16E-01	0.83	0.83	2.20E-04	1.17E-01

Summary of Tank V-9 (Continue)

Data Set	Constituent	Slurry Reporting Basis	Slurry UNIT	Slurry Phase (weight fraction) Data pt #1	Data pt #2	Data pt #3	Data pt #4	Data pt #5	AVG Wt Fraction	Sludge Phase Total Constituent, Kg	Liquid Phase Data pt #1	AVG mg/L	Liquid Phase Total Constituent, Kg	Total Tank Total Constituent, Kg
1996	di-n-butylphth	Dry weight	wt fraction	1.50E-05	1.30E-05				1.40E-05	6.27E-03			0.00E+00	6.27E-03
1996	phenanthrene	Dry weight	wt fraction	2.10E-05	1.90E-05				2.00E-05	8.95E-03			0.00E+00	8.95E-03
1996	pyrene	Dry weight	wt fraction						0.00E+00	0.00E+00			0.00E+00	0.00E+00
1996	phenol	Dry weight	wt fraction	6.80E-05	7.10E-05				6.95E-05	3.11E-02	0.1	0.1	2.65E-05	3.11E-02
1996	4,6,-dinitro-2-methylphenol	Dry weight	wt fraction							0.00E+00	0.19	0.19	5.03E-05	5.03E-05
1996	4-nitrophenol	Dry weight	wt fraction							0.00E+00	0.037	0.037	9.80E-06	9.80E-06
1996	di-n-octylphthalate	Dry weight	wt fraction							0.00E+00	0.006	0.006	1.59E-06	1.59E-06
1996	tributylphosphate	Dry weight	wt fraction							0.00E+00	0.19	0.19	5.03E-05	5.03E-05
1996	**Total Carbon**	Slurry	wt fraction	1.00E-02	1.29E-02				1.15E-02	1.22E+01	3.1	3.1	8.21E-04	**1.70E+01**
									AVG (nCi/g	Total Constituent, Ci	Liquid Phase (nCi/L)	AVG (nCi/L	Total Constituent, Ci	Total Tank Total Constituent, Ci
1996	**Pu-238**	Slurry	nCi/g	11.5	28.6				2.01E+01	2.14E-02	170	170	4.50E-05	2.14E-02
1996	**Pu-239/240**	Slurry	nCi/g	7.38	7.18				7.28E+00	7.76E-03	45.3	45.3	1.20E-05	7.77E-03
1996	**Am-241**	Slurry	nCi/g	4.3	5.7				5.00E+00	5.33E-03	40.2	40.2	1.07E-05	5.34E-03
1996	Cm-242	Slurry	nCi/g	0	0				0.00E+00	0.00E+00				0.00E+00
1996	**Cm-243/244**	Slurry	nCi/g	0.453	0.704				5.79E-01	6.16E-04	5.2	5.2	1.38E-06	6.18E-04
1996	**Np-237**	Slurry	nCi/g	0.027	0.033				3.00E-02	3.20E-05	0.2	0.2	5.30E-08	3.20E-05
	Total TRU								0.00E+00					**9.77E-02**
1996	U-233/234	Slurry	nCi/g	7.08	13.4				1.02E+01	1.09E-02	223	223	5.91E-05	1.10E-02
1996	U-235	Slurry	nCi/g	0.255	0.45				3.53E-01	3.76E-04	6.9	6.9	1.83E-06	3.77E-04
1996	U-238	Slurry	nCi/g	0.078	0.0825				8.03E-02	8.55E-05	0.97	0.97	2.57E-07	8.58E-05
1996	Sr-90	Slurry	nCi/g	5740	7070				6.41E+03	6.82E+00	250000	250000	6.62E-02	6.89E+00
1996	Ag-108	Slurry	nCi/g						0.00E+00	0.00E+00			0.00E+00	0.00E+00
1996	Ag-110	Slurry	nCi/g						0.00E+00	0.00E+00			0.00E+00	0.00E+00
1996	Ce-144	Slurry	nCi/g						0.00E+00	0.00E+00				0.00E+00
1996	Co-58	Slurry	nCi/g						0.00E+00	0.00E+00			0.00E+00	0.00E+00
1996	Co-60	Slurry	nCi/g	1160	726				9.43E+02	1.00E+00	1.18	1.18	3.13E-07	1.00E+00
1996	Cs-134	Slurry	nCi/g						0.00E+00	0.00E+00				0.00E+00
1996	**Cs-137**	Slurry	nCi/g	4810	6370				5.59E+03	5.96E+00	420	420	1.11E-04	**9.04E+00**
1996	Eu-152	Slurry	nCi/g	0	0				0.00E+00	0.00E+00	0.57	0.57	1.51E-07	1.51E-07
1996	Eu-154	Slurry	nCi/g	22.2	0				1.11E+01	1.18E-02	0.27	0.27	7.15E-08	1.18E-02
1996	Eu-155	Slurry	nCi/g						0.00E+00	0.00E+00			0.00E+00	0.00E+00
1996	Mn-54	Slurry	nCi/g						0.00E+00	0.00E+00			0.00E+00	0.00E+00
1996	Nb-95	Slurry	nCi/g						0.00E+00	0.00E+00			0.00E+00	0.00E+00
1996	Ra-226	Slurry	nCi/g						0.00E+00	0.00E+00			0.00E+00	0.00E+00
1996	Ru-103	Slurry	nCi/g						0.00E+00	0.00E+00			0.00E+00	0.00E+00
1996	Ru-106	Slurry	nCi/g						0.00E+00	0.00E+00			0.00E+00	0.00E+00
1996	Sb-125	Slurry	nCi/g						0.00E+00	0.00E+00			0.00E+00	0.00E+00
1996	Zn-65	Slurry	nCi/g						0.00E+00	0.00E+00			0.00E+00	0.00E+00
1996	Zr-95	Slurry	nCi/g						0.00E+00	0.00E+00			0.00E+00	0.00E+00
1996	I-129	Slurry	nCi/g						0.00E+00	0.00E+00			0.00E+00	0.00E+00
1996	Ni-63	Slurry	nCi/g						0.00E+00	0.00E+00			0.00E+00	0.00E+00
1996	H-3	Slurry	nCi/g						0.00E+00	0.00E+00	353000	353000	9.35E-02	9.35E-02

Total Composite of Waste in the V-Tanks

Data Set	Constituent	Weight of constituent in kg				
		Tank V-1	Tank V-2	Tank V-3	Tank V-9	Entire V-Tanks
1980	Al	3.38E+00	6.79E+00	8.12E+00	3.58E+00	2.19E+01
1980	Ca	1.14E+01	1.36E+01	2.06E+01	8.97E+00	5.46E+01
1980	Cr	3.37E+00	6.79E+00	8.12E-01	2.51E+00	1.35E+01
1980	Fe	1.69E+01	3.39E+01	5.07E+01	1.94E+01	1.21E+02
1980	Mg	1.69E+01	1.36E+01	3.05E+01	1.20E+01	7.31E+01
1980	Mn	4.50E+00	1.36E+01	1.02E+01	5.67E+00	3.39E+01
1980	Si	1.35E+02	1.36E+02	1.93E+02	9.40E+01	5.57E+02
1980	P	6.17E+01	8.15E+01	1.32E+02	5.37E+01	3.29E+02
1996	Sb	3.29E-02	3.25E-02	3.02E-02	1.52E-02	1.11E-01
1996	As	1.92E-02	2.10E-02	2.71E-02	0.00E+00	6.72E-02
1996	Ba	2.76E-01	2.30E-01	3.62E-01	3.98E-01	1.27E+00
1996	Be	5.32E-02	2.54E-02	4.69E-02	2.68E-02	1.52E-01
1996	**Cd**	**2.46E-01**	**1.90E-01**	**2.02E-01**	**4.49E-02**	**5.71E-01**
1996	CN	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1996	F	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1996	Pb	1.63E+00	1.84E+00	2.29E+00	6.03E-01	6.37E+00
1996	**Hg**	**2.24E+00**	**1.86E+00**	**2.93E+00**	**2.63E+00**	**7.25E+00**
1996	Ni	5.22E-01	4.62E-01	7.50E-01	4.24E-01	2.16E+00
1996	Se	0.00E+00	7.47E-03	0.00E+00	0.00E+00	7.47E-03
1996	Ag	2.25E-01	3.07E-01	2.19E-01	6.94E-01	1.45E+00
1996	S	4.49E-02	1.69E-02	1.65E-02	2.56E-05	7.83E-02
1996	Tl	0.00E+00	0.00E+00	0.00E+00	4.16E-03	4.16E-03
1996	V	1.02E-02	0.00E+00	1.37E-02	6.50E-03	3.04E-02
1996	Zn	2.86E+01	2.54E+00	1.18E+01	1.87E+00	4.47E+01
1996	**Cl**	**1.78E+00**	**1.24E+00**	**8.94E-01**	**1.18E+00**	**4.20E+00**
1996	Na	6.48E+00	3.89E+00	4.29E+00	2.56E+00	1.72E+01
1996	K	3.33E+00	4.33E+00	2.52E+00	1.14E+01	2.15E+01
1996	**Aroclor-1260**	**3.31E-01**	**1.91E-01**	**4.60E-01**	**2.05E-01**	**9.85E-01**
1993	TCE	2.47E-02	2.42E-03	2.84E-03	1.93E+01	1.93E+01
1993	PCE	2.81E+00	8.38E-01	1.14E+00	5.65E-01	5.35E+00
1993	chloromethane	0.00E+00	0.00E+00	0.00E+00	7.41E-02	7.41E-02
1993	bromomethane	0.00E+00	0.00E+00	0.00E+00	1.39E-01	1.39E-01
1993	TCA	3.12E-03	1.13E-03	1.55E-03	2.36E+00	2.37E+00
1993	1,2-dichloroethylene	2.56E-04	1.59E-03	1.26E-03	0.00E+00	3.11E-03
1993	1,1-dichloroethane	0.00E+00	1.55E-04	1.19E-04	0.00E+00	2.75E-04
1993	vinyl chloride	0.00E+00	8.61E-05	6.92E-05	0.00E+00	1.55E-04
1993	methylene chloride	0.00E+00	0.00E+00	0.00E+00	1.56E-02	1.56E-02
1996	2-methy naph	6.13E-03	2.46E-02	1.85E-02	4.70E-02	9.62E-02
1996	1,2-dichloroben	0.00E+00	1.30E-02	2.61E-02	1.41E-01	1.80E-01
1996	naphthalene	0.00E+00	2.37E-03	0.00E+00	1.83E-02	2.07E-02
1996	**bis(2-ethylhexyl) phthalate**	**8.99E+00**	**7.38E+00**	**1.37E+01**	**7.35E-01**	**2.58E+01**
1996	1,2,4-trichloroben	0.00E+00	0.00E+00	0.00E+00	1.30E-02	1.30E-02
1996	1,3-dichloroben	0.00E+00	0.00E+00	0.00E+00	6.49E-03	6.49E-03
1996	1,4-dichloroben	0.00E+00	0.00E+00	0.00E+00	3.65E-02	3.65E-02
1996	2,4-dimethylphen	0.00E+00	0.00E+00	0.00E+00	1.19E-01	1.19E-01
1996	2-methylphenol	0.00E+00	0.00E+00	0.00E+00	2.22E-01	2.22E-01
1996	4-methylphenol	0.00E+00	0.00E+00	0.00E+00	1.17E-01	1.17E-01
1996	di-n-butylphth	0.00E+00	0.00E+00	0.00E+00	6.27E-03	6.27E-03
1996	phenanthrene	0.00E+00	0.00E+00	0.00E+00	8.95E-03	8.95E-03
1996	pyrene	0.00E+00	1.12E-04	3.96E-04	0.00E+00	5.08E-04
1996	pheno	0.00E+00	0.00E+00	0.00E+00	3.11E-02	3.11E-02
1996	4,6,-dinitro-2-methylpheno	0.00E+00	0.00E+00	0.00E+00	5.03E-05	5.03E-05
1996	4-nitropheno	0.00E+00	0.00E+00	0.00E+00	9.80E-06	9.80E-06
1996	di-n-octylphthalate	0.00E+00	0.00E+00	0.00E+00	1.59E-06	1.59E-06
1996	tributylphosphate	0.00E+00	0.00E+00	0.00E+00	5.03E-05	5.03E-05
1996	**Total Carbon**	**1.48E+02**	**2.98E+02**	**3.45E+02**	**1.70E+01**	**7.07E+02**
		Total Tank	Total Tank	Total Tank	Total Tank	
		Total Constituent, Ci	Total Constituent, Ci	Total Constituent, Ci	Total Constituent, Ci	Total Constituent, Ci
1996	**Pu-238**	2.41E-02	1.12E-02	2.91E-02	2.14E-02	8.58E-02
1996	**Pu-239/240**	1.10E-02	9.44E-03	1.50E-02	7.77E-03	4.32E-02
1996	**Am-241**	2.71E-02	3.52E-03	1.56E-02	5.34E-03	5.15E-02
1996	Cm-242	3.85E-03	6.20E-06	1.44E-05	0.00E+00	3.87E-03
1996	**Cm-243/244**	7.98E-03	2.29E-04	4.38E-03	6.18E-04	1.32E-02
1996	**Np-237**	0.00E+00	0.00E+00	0.00E+00	3.20E-05	3.20E-05
	Total TRU	**9.94E-02**	**3.11E-02**	**8.36E-02**	**9.77E-02**	**2.36E-01**
1996	U-233/234	6.73E-03	4.75E-03	4.94E-03	1.10E-02	2.74E-02
1996	U-235	2.04E-04	1.47E-04	1.61E-04	3.77E-04	8.90E-04
1996	U-238	1.10E-04	1.28E-04	1.49E-04	8.58E-05	4.73E-04
1996	Sr-90	9.76E+00	1.94E+01	4.72E+01	6.89E+00	8.33E+01
1996	Ag-108	0.00E+00	2.67E-04	0.00E+00	0.00E+00	2.67E-04
1996	Ag-110	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1996	Ce-144	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1996	Co-58	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1996	Co-60	3.08E-01	3.81E-01	4.08E-01	1.00E+00	2.10E+00
1996	Cs-134	1.97E-03	1.12E-04	3.05E-03	0.00E+00	5.13E-03
1996	**Cs-137**	**1.72E+01**	**1.81E+01**	**2.23E+01**	**9.04E+00**	**5.51E+01**
1996	Eu-152	4.46E-02	2.28E-02	3.98E-02	1.51E-07	1.07E-01
1996	Eu-154	6.01E-02	3.28E-02	6.84E-02	1.18E-02	1.73E-01
1996	Eu-155	6.83E-04	1.93E-03	1.01E-03	0.00E+00	3.62E-03
1996	Mn-54	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1996	Nb-95	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1996	Ra-226	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1996	Ru-103	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1996	Ru-106	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1996	Sb-125	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1996	Zn-65	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1996	Zr-95	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1996	I-129	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
1996	Ni-63	2.13E+00	1.31E+00	2.08E+00	0.00E+00	5.51E+00
1996	H-3	1.34E-01	4.39E-01	3.83E-02	9.35E-02	7.05E-01

Note: Cl includes the inorganic chlorides and the chlorides associated with PCBs

Appendix B

Sample Calculation for 95% Upper Confidence Level

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Sample Calculation for 95% Upper Confidence Level

In Appendix A, the key measured constituents and properties of the V-tanks were identified. These were divided into two categories: Contaminants for Treatment (the constituents that have regulatory drivers) and Key Analytes (a subset of the contaminants for treatment that are of a higher priority). A statistical upper confidence limit of 95% was used on the key analytes to ensure any process design could adequately account for these constituents. This appendix will illustrate how these values were increased to the 95% upper confidence level to provide a measure of assurance that the data were used in a conservative fashion for flow sheet use (equipment [identification and sizing] and additives [reagents and binders]). For the sludge phase, the data from sampling activities is reported as a concentration on either a dry basis (SVOCs and PCB analysis) or on a wet solids/slurry basis (inorganics, radionuclides, VOCs, etc.). For flow sheet evaluation (material balance), the contents of the V-tanks need to be converted to an absolute weight within the tank. The following are some assumptions used for this calculation:

- Since samples in 1993 were obtained in a COLIWASA and the solids were allowed to sit undisturbed as the aqueous layer was decanted, the percent solids reported for each V-tank are assumed to represent the actual sludge layer in each V-tank. The percent solids (by weight) were averaged for each tank and assigned a standard error.[f] Average and error were determined by the feasibility study team.

- Wet-based concentrations for the sludge phase (based on gravity filtered samples) of measured analytes for 1996 data have associated percents solid values. For each V-tank, the percent solids of the gravity-filtered sludges were averaged and assigned a standard error. The feasibility study team determined average and error.

- The specific gravity of the sludge in Tanks V-1, V-2, and V-3 were reported in 1996 miscellaneous data and averaged with a standard error reported. The specific gravity of the sludge in Tank V-9 was determined from the rock grain (dry) density with the assumed solids loading in the sludge to determine density (no standard error).

A sampling team determined the volume of sludge in each tank in 1996[g]. They assumed that the sludge volume could be off by one inch. A volume was estimated for the sludge and the incremental volume addition (due to the one inch) was assumed to bring the total volume to the 95% upper confidence limit. The standard error was back calculated from this value. Since Tank V-9 has a unique geometry, it was assumed that a volume range of 50 gallons for the sludge could be back calculated to determine a standard error.

Using these assumptions, a protocol for determining a total constituent weight per tank would be:

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f. Since Tank V-9 was not sampled until 1996, the percent solids that were obtained in 1996 were used to estimate the percent solids of the sludge phase in that tank.

g. The direct determination was based on a vertical distance converted to a volumetric value based on tank geometry. A table was constructed that converted height to volume and reported this by one inch increments.

1. Determine the basis for the concentration in the sludge (wet vs. dry).

2. If on a wet basis, determine the average and standard error.

3. If the wet based concentrations were from sampling in 1996, divide the wet basis average concentration by the average percent solids (by weight) determined for the given tank in the 1996 gravity filtration.

4. Multiply the value determined in Step 3 by the average percent solids (by weight) determined for the given tank in the 1993 decant. The combined effects of Step 2 and 3 allow the data to be presented in terms of the defined actual sludge phase.

5. Multiply the value determined in Step 4 by the average value of sludge density. This puts the concentration on a weight per volume basis.

6. Multiply the value determined in Step 5 by the reported estimated volume of sludge as given for each tank. This provides the total weight of constituent in the sludge phase.

7. If the wet based concentrations were from sampling in 1993, start with Step 5.

8. If the concentrations are reported on a dry basis, start with Step 4.

This calculation procedure will determine the total average weights of any constituent that was measured in the sludge phase. The liquid phase concentration is simply the average of the concentrations (expressed per liter) multiplied the volume of the aqueous phase in the tanks. For most of the constituents, only the average total weights are presented. For the eight constituents presented in Appendix A, a standard error is reported with the resultant calculation such that a 95% upper confidence level (UCL) can be reported. This 95% UCL provides a cushion for regulatory and design considerations. The following section will provide a simple example of how these were determined.

Let a and b represent average values of a parameter with s(a) and s(b) representing the respective standard errors. If a and b are used to calculate a value for c = f(a,b), the propagated error for c would be:

$$s_c = \sqrt{\left(\frac{\partial f}{\partial a}\right)^2 s_a^{\,2} + \left(\frac{\partial f}{\partial b}\right)^2 s_b^{\,2}}$$

where

$$u_a^{\,2} = \left(\frac{\partial f}{\partial a}\right)^2 s_a^{\,2} \qquad\qquad u_b^{\,2} = \left(\frac{\partial f}{\partial b}\right)^2 s_b^{\,2}$$

In addition to propagating errors, the degrees of freedom need to be tracked prior to applying the 95% UCL. Let the degrees of freedom for a and b be represented by D_a and D_b. The resulting degrees of freedom would be:

$$D_c = \frac{s_c^{\ 4}}{\frac{u_a^{\ 4}}{D_a} + \frac{u_b^{\ 4}}{D_b}}$$

For a sample calculation, consider the calculation of the sludge weight of cadmium from Tank V-1. The following data are presented:

Average concentration of Cd in wet sludge:	a = 102 mg/kgws
Standard error of Cd concentration:	s_a = 34 mg/kgws
Average fraction of dry solids in wet sludge (1996):	b = 0.443 kgds/kgws
Standard error of 1996 dry to wet:	s_b = 0.080 kgds/kgws
Average fraction of dry solids in wet sludge (1993):	c = 0.28 kgds/kgws
Standard error of 1996 dry to wet:	s_c =0.005 kgds/kgws
Average wet sludge density:	d = 1.017 kgws/Lws
Standard error of wet sludge density:	s_d = 0.003 kgws/Lws
Volume of wet sludge:	e = 1968 Lws
Standard error of wet sludge volume:	s_e = 125 Lws

Weight of Cadmium (kg) in Sludge (average):

$$WT_{Cd} = \frac{acde}{(1.0E+6)b} = \frac{(102)(0.28)(1.017)(1968)}{(0.443)(1.0E+6)} = 0.129\ kg$$

The propagated standard error is:

$$s_{cd} = \sqrt{\left(\frac{\partial f}{\partial a}\right)^2 s_a^{\ 2} + \left(\frac{\partial f}{\partial b}\right)^2 s_b + \left(\frac{\partial f}{\partial c}\right)^2 s_c + \left(\frac{\partial f}{\partial d}\right)^2 s_d + \left(\frac{\partial f}{\partial e}\right)^2 s_e}$$

Where:

$$f(a,b,c,d,e) = (1.0E-6)acdeb^{-1}$$

$$\frac{\partial f}{\partial a} = (1.0E-6)cdeb^{-1},\quad \frac{\partial f}{\partial b} = -(1.0E-6)acdeb^{-2},\quad \frac{\partial f}{\partial c} = (1.0E-6)adeb^{-1}$$

$$\frac{\partial f}{\partial d} = (1.0E-6)aceb^{-1},\quad \frac{\partial f}{\partial e} = (1.0E-6)acdb^{-1}$$

$$s_{Cd} = (1.0E-6)\sqrt{\frac{c^2d^2e^2s_a^{\ 2}}{b^2} + \frac{a^2c^2d^2e^2s_b^{\ 2}}{b^4} + \frac{a^2d^2e^2s_c^{\ 2}}{b^2} + \frac{a^2c^2e^2s_d^{\ 2}}{b^2} + \frac{a^2c^2d^2s_e^{\ 2}}{b^2}}$$

Plugging in the values from above gives:

$$s_{Cd} = (1.0E-6)(49600) \;=\; 0.0496\,kg$$

The mass of cadmium in the sludge phase of Tank V-1 is 0.129 *kg* with a standard error of 0.05 *kg*. The associated degrees of freedom that is used for this value is determined by the degrees of freedom of the other values.

Average concentration of Cd in wet sludge:	$D_a = 2$
Average fraction of dry solids in wet sludge (1996):	$D_b = 4$
Average fraction of dry solids in wet sludge (1993):	$D_c = 1$
Average wet sludge density:	$D_d = 2$
Volume of wet sludge:	$D_e = 100$

The volume of wet sludge was estimated by a ruled measure with a perceived confidence (95%) of $\pm$1 inch. The one-inch variation was used geometrically to estimate a maximum volume increase. The standard error was back-calculated from this value assuming an infinite degree of freedom. The degree of freedom for the volume was assigned an arbitrarily high value of 100. For the other parameters, the degrees of freedom were determined from the number of actual data points minus one. The resulting degree of freedom from the above calculation is determined as:

$$D_{Cd} = \frac{s_{Cd}^{\;4}}{\dfrac{u_a^{\;4}}{D_a} + \dfrac{u_b^{\;4}}{D_b} + \dfrac{u_c^{\;4}}{D_c} + \dfrac{u_d^{\;4}}{D_d} + \dfrac{u_e^{\;4}}{D_e}}$$

$$D_{Cd} = \frac{s_{Cd}^{\;4}}{\dfrac{c^4 d^4 e^4 s_a^{\;4}}{b^4 D_a} + \dfrac{a^4 c^4 d^4 e^4 s_b^{\;4}}{b^8 D_b} + \dfrac{a^4 d^4 e^4 s_c^{\;4}}{b^4 D_c} + \dfrac{a^4 c^4 e^4 s_d^{\;4}}{b^4 D_d} + \dfrac{a^4 c^4 d^4 s_e^{\;4}}{b^4 D_e}}$$

Substituting the values for the variables yields a degree of freedom of 3.40. If further calculations are made, this degree of freedom along with the standard error will carry forward. If no further immediate calculation is needed, but a bounding value, such as a 95% UCL is desired, the following equation is used:

$$WT_{Cd}\big|_{95\%UCL} \;=\; WT_{Cd} + t s_{Cd}$$

Where t is determined by using the degrees of freedom (D_{Cd} = 3.4) and letting $\alpha = 0.05$ (for one-sided, 95%) using the t-distribution curve. In Excel Spreadsheet calculations, this is the TINV function. This function truncates the degree of freedom calculation, which means a higher t value and thus a higher contaminant amount at the 95% UCL. Since this represents a worst-case situation, the truncation was allowed. In this example, assuming all of the cadmium in Tank V-1 was in the sludge phase, the 95% UCL for cadmium weight in Tank V-1 is:

$$WT_{Cd}\big|_{95\%UCL} = 0.129 + (2.353)(0.05) \;=\; 0.246\,kg\ of\ Cd$$